Vol. 17, No. 159. MARCH, 1915. [Price SIXPENCE Net.

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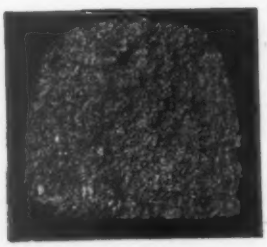
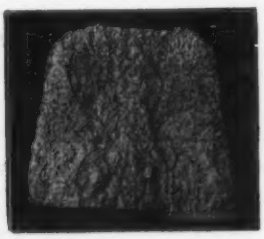

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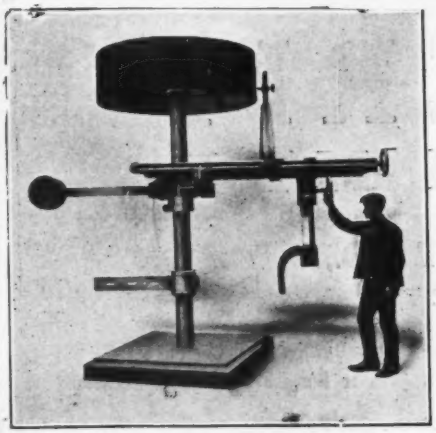

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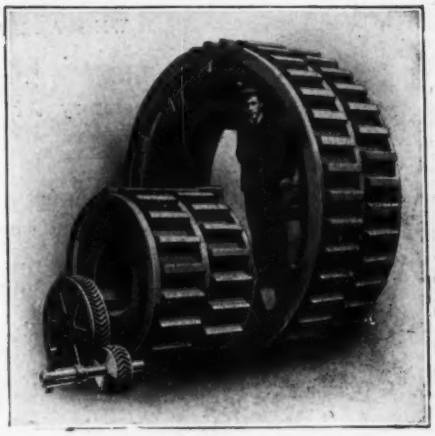

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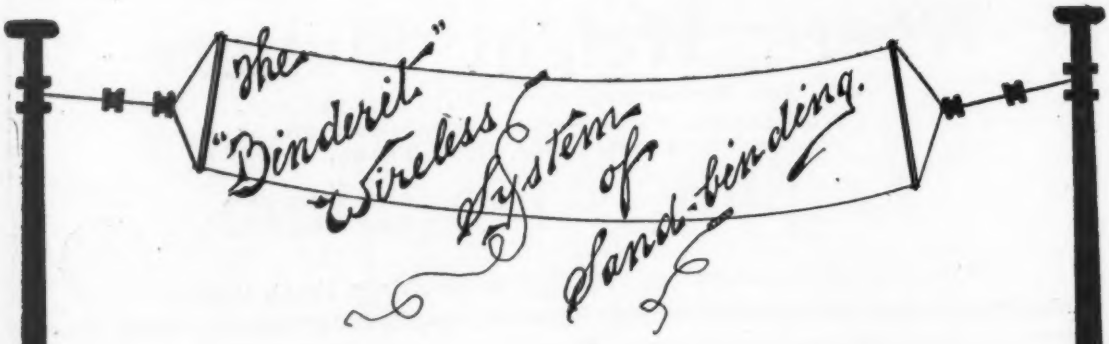

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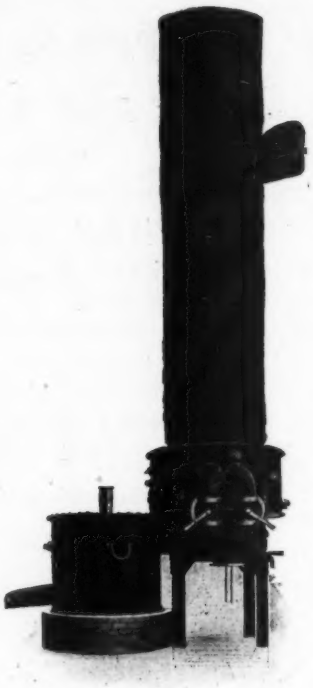

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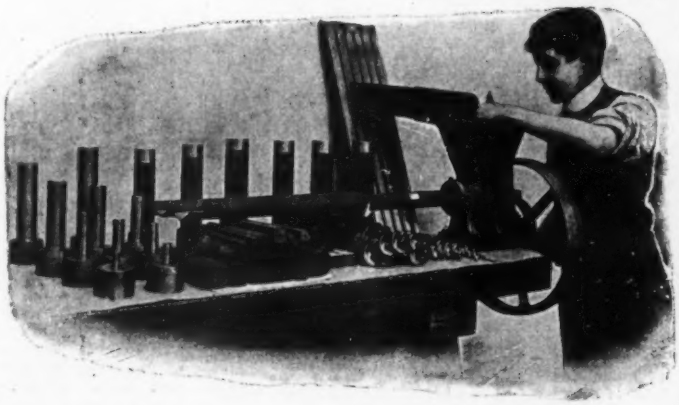

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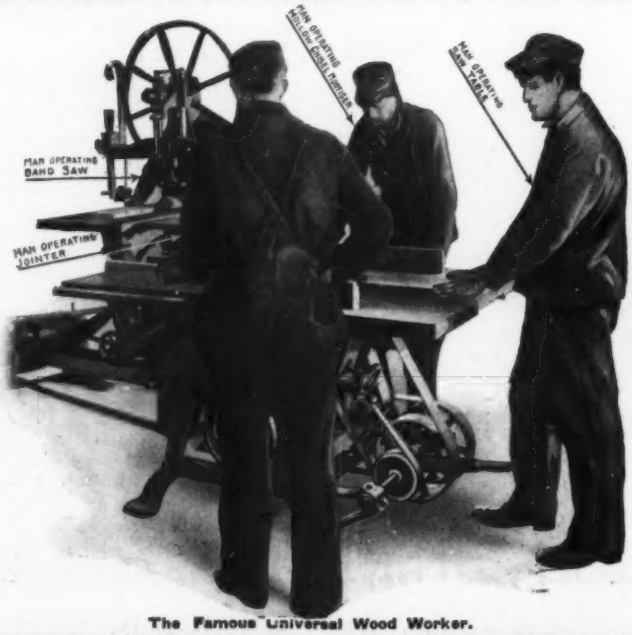

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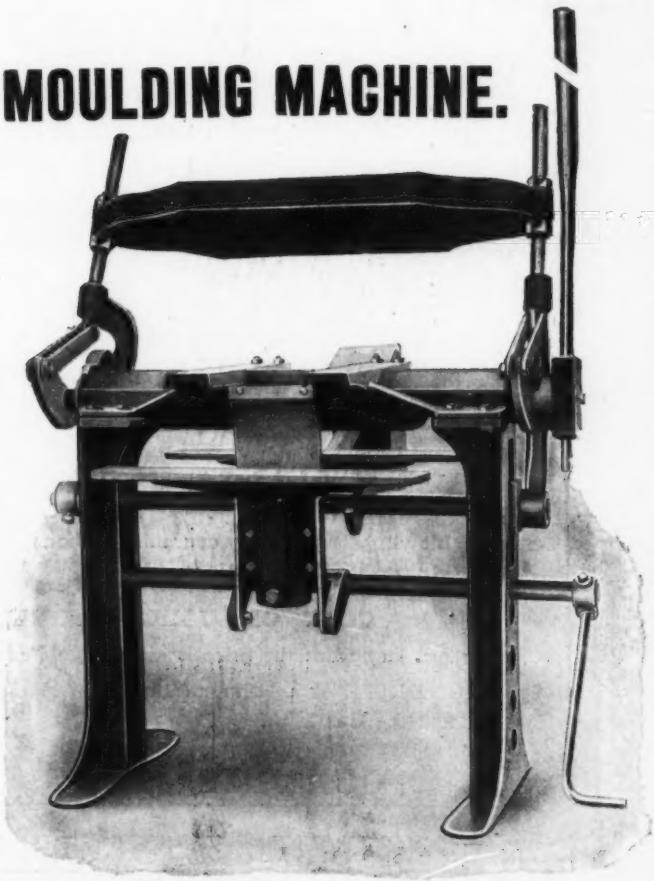

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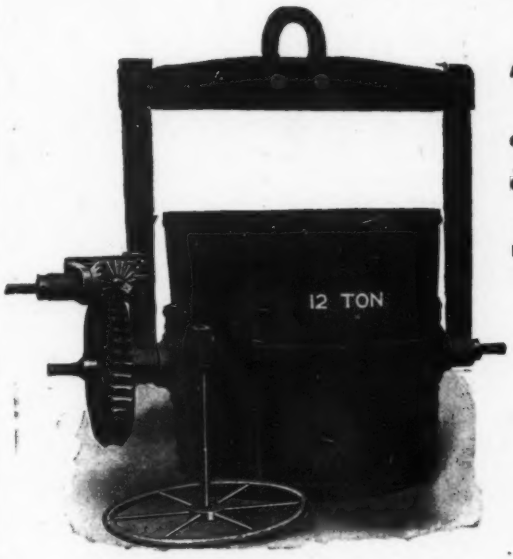

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159

The Foundry Trade Journal
AND PATTERN-MAKER.
THE OFFICIAL ORGAN OF THE BRITISH FOUNDRYMEN'S ASSOCIATION.

Vol. 17. **MARCH, 1915.** **No. 159.**

PUBLISHED THE FIRST WEEK IN EACH MONTH.

Subscription Terms: 7s. 6d. per annum, post free.

To place the "Journal" within the reach of Working Moulders and Pattern-makers, the Proprietors will accept subscriptions, not less than three in number from one shop, at the reduced rate of 5s. per annum, such order to be countersigned by the superintendent or foreman.

All communications to be addressed to the Editor, or to the Publisher, as the case may be, of

The Foundry Trade Journal,
165, Strand, London, W.C.

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British Foundrymen's Association (Halifax Branch).—"Copper Alloys, with Notes on Brass Founding," by H. L. Reason.

British Foundrymen's Association (Lancashire Branch).—"Copper-Aluminium Alloys," by Prof. C. A. Edwards, D.Sc.

MARCH 13.

British Foundrymen's Association (Birmingham Branch).—"Malleable Castings," by W. H. Hadfield, D.Met.

MARCH 26.

British Foundrymen's Association (London Branch).—"Mixtures of Iron for High-Class Castings," by Harry Pemberton (Derby).

MARCH 27.

British Foundrymen's Association (Scottish Branch).—Annual meeting and discussion on "Foundry Problems."

British Foundrymen's Association (Newcastle-on-Tyne Branch).—Paper by H. Pilkington (Chesterfield).

British Foundrymen's Association (Birmingham Branch).—"Foundry Organisation," by A. Harley (Coventry).

NOTES AND COMMENTS.

Some Influences on Coke Prices.

It is of interest to fuel users to note how the influences exerted on the coal market by present conditions have reacted on coke prices. Taking coke prices throughout the country, they do not appear to have risen in keeping with the rises exhibited by coal. The case, however, varies in each district, owing to the conditions and class of trade. In London, whose supply of foundry coke is drawn entirely from outside sources, the effect of high carriage rates and transport disorganisation is being heavily felt. On the Newcastle-on-Tyne market, however, foundry coke is now at about the same level as twelve months ago, and lower than during the first two months of the war. The reason for this is that the restriction of exports from the Tyne has placed a large amount of coking coal at the disposal of local consumers, and so long as transport rates and difficulties operate against a ready distribution of that coal, there will probably be no material rise in the local prices. Middlesbrough is similarly situated, for there again foundry coke stands at about the level of twelve months ago. Turning to South Wales and the Midlands, we find a different state of affairs. On the Cardiff market special foundry coke commands 33s. to 36s., as compared with 27s. to 28s. at the early part of March last year, while ordinary foundry coke stands at 28s. to 32s., as compared with 23s. to 26s. These increases are not great in the circumstances, nor do they appear to result so much from increased demand as decreased supply, owing to the higher prices of descriptions of coal for consumption without coking drawing from the coke ovens' supplies of raw material. In fact, it is stated that the position is becoming rather critical for coke-oven owners, who are only being enabled to keep their ovens operating by reason of the value of the by-products, the carbonisation alone being carried on at a loss. The scarcity of labour, and, in many cases, the necessity of employing fresh men and training them to the work, combined with the increased cost of coal, has increased the cost of coke making, while, further, several new installations of by-product ovens have recently been put into operation, and the additional amount of coke thus thrown on the market has also tended to keep down the price. It is considered in some quarters that there is a danger of over-production and some closing down of ovens is to be expected in order to make the supply conform with the reduced demand. Modern ovens are very flexible in this respect, but labour costs remain very much the same with a considerable diminution in output as when working at normal load. The difficulty from the coke-makers' standpoint is aggravated by the present low prices of by-products; and while a modern plant can often stand a loss on the coke as such, it obviously cannot stand a loss on the by-products also. In view of these facts, coke users must be prepared to face

either a curtailment of supply in the near future and a consequent increase in prices, or a stimulated consumption operating to the same end.

British Industry and the Allies' Requirements.

The importance of maintaining British industries in as efficient a condition as possible is not only a matter for this country but also has a most important bearing on the conduct of the war. This fact is brought home to us very forcibly by certain statements made at a recent meeting at Düsseldorf (Germany) of the Association of German Eisenhüttenleute, when Dr. Schrödter and Dr. Beumer read papers discussing the iron industry during the war. The statements were, of course, presented in a manner calculated to add to the importance of the German occupation of Belgium and certain French Departments, and to show what important progress Germany had made in strangling French resistance; but nevertheless, the facts of the position, stripped of their sentimental value as affecting German opinion, are of sufficient interest to warrant reiteration.

Dr. Schrödter, who has visited the districts occupied by the Germans, stated that the displacement in economic conditions had been the greatest in France and Belgium. In France part of 10 French Departments, covering an area of 5,187,000 acres and having a population of 3,255,000 persons, were in German occupation, and the latter consequently had in their possession 68.8 per cent. of the total production of coal, 78.3 per cent. of the make of coke, 90 per cent. of the iron ore, 85.7 per cent. of the pig-iron, 76 per cent. of the raw material (including 95.3 per cent. of the basic steel and 76.9 per cent. of the steel castings), and the entire production of tubes. With the exception of a few minor iron-ore fields the whole of the output of iron ore lay within the scope of German arms, and the same observation applied to the whole industry which extended from the Belgian frontier to the north-east coast. A considerable portion of the coalfields was similarly held, so that the supply of coal for France appeared very difficult, especially as Great Britain was deficient in effecting deliveries. As to the engineering industry, which was concerned with the building of locomotives and railway wagons, Dr. Schrödter remarked that the greatest portion was in German ownership, and only one works still belonged to the French, namely, at Belfort.

Discussing next the occupation of Russian territory, the author stated that the district under German influence at the moment contained about 25 per cent. of the Russian coal production; while as to Belgium, in that country the iron industry was almost entirely paralysed by the war. The country had hitherto procured her iron ore from abroad, and on the other hand, had exported about 75 per cent. of her manufactures. Under existing conditions there was therefore no prospect of the iron industry being able to resume to any extent, although the German administration was endeavouring to restore industrial activity. This effort had succeeded in the coal industry, which had now nearly reached one-half of the normal production.

From the foregoing it will be seen that Great Britain is called upon to make good for the time being the incapacity of her allies to meet their own requirements both in war material and industrial iron and steel. To what extent the United States will also contribute to those requirements is uncertain, though, of course, as the world's largest iron producer that country must be expected to share in any distribution of work created by the new conditions. So far, however, the main brunt of the pressure appears to have been borne by Great Britain.

German Labour Conditions.

No great surprise will be felt at the rosy tints with which the before-mentioned authority attempted to paint the picture of German labour conditions, though the statement that the accommodation of industry to the changed conditions brought about by the war had been completed will not necessarily be accepted as absolutely veracious. According to Dr. Schrödter, work was on hand everywhere, although many establishments, especially in the more highly manufacturing branches, had greatly suffered. He discussed the possibility of obtaining raw materials and mentioned in particular the obligation due to German science and engineering which, through new inventions and processes, were furnishing more than sufficient substitutes for the raw materials in which they were lacking. Dr. Beumer also contended that the iron and steel trades had admirably accommodated their works to the completely changed circumstances, but their situation was not brilliant, and they had continually to fight against difficulties which would still require the greatest exertion and energy. In the first place the cost of production had become higher owing to the war, and sale prices were only moderately satisfactory, as many works had maintained operations out of consideration for the officials and workmen who had not been withdrawn. It was therefore only natural that the works should attempt to obtain remunerative orders, but this had been rendered impossible for a long time in consequence of "a parasitic intermediary trade" (the merchants). A specially strong influence on the increased working expenses was also exercised by the course of labour conditions. Unemployment only existed in imagination, and with few exceptions it could be said that those in Germany who wished to work had abundant opportunity of doing so at the present time. What unemployment did exist was wholly in the case of the work-shy; that was recognised in the coal and iron and steel industries, also by the Trade Unions, and the work-shy had assumed a regrettable extension. He suggested that the men should be compelled to work; unemployed in other districts should be requisitioned in order to assist in the work.

The latter contribution to this discussion is particularly interesting, though it would be impossible for other than German military organisation to requisition the unemployed in other districts when unemployment "only exists in imagination." Probably, however, German imagination approximates more closely to realisation than does the British brand, for we see that according to the "Reichsarbeitersblatt," the number of unemployed on the lists of the German Trade Unions in the fourth quarter of 1914 was 339,330, or 26.8 per cent. According to other returns, however, published by the German Department of Labour Statistics, the unemployment recorded by 40 Trade Unions was 10.9 per cent. in October, 8.2 per cent. in November, and 7.2 per cent. in December last. These figures compare badly with the 2.5 per cent. recorded by British Trade Unions at the close of 1914. Either German industrial conditions are very badly upset or—may we be forgiven for daring to suggest it—German organisation is not infallible. Further, a country which, after withdrawing several millions of men from industry for military purposes, can show even 7 per cent. of unemployment in its Trade Unions as the result of work-shy dispositions, and at a time when every effort of organisation and application should be turned to producing the nation's requirements, presents an interesting study in psychology.

Jobbing Pipes, 2½ in. to 12 in.*

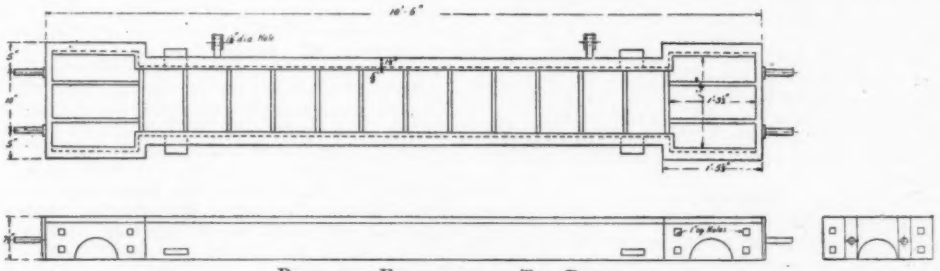
By James Hogg.

To make jobbing pipes successfully one needs to be able not only to mould them right, but also to get through them very quickly, and a man who can do this is a very useful asset to a foundry where a number of jobbing pipes are turned out. The size of pipe most commonly met with varies from 2½ in. core to 12 in. core. These are made in tens of thousands in this country every year. I call jobbing pipes all those pipes which differ from the ordinary 9-ft. or 12-ft. lengths of straight piping, and there is a marked difference in the price between straight pipes and jobbing pipes, either socket or flanged. There are elbow pipes, crank pipes, branch pipes, tee pipes, pudding pipes, four-way pipes, bend pipes, reduced pipes, double elbows, double cranks, pipes under or over standard straight lengths, pipes which have bosses cast on for tapping, and also 9-ft. or 12-ft. lengths with odd flanges on them. All these come under the heading of jobbing pipes, and I myself believe in devising methods of producing these pipes cheaply and sound. To make these pipes with any chance of success one must have good tackle, i.e., patterns and boxes, also core barrels. Any foundry making a speciality of pipes, or even a foundry making a few occasionally, should have proper boxes, or the moulder cannot do himself justice. These boxes can be made very cheaply, and if made the right way they will not only lend themselves to the making of almost any kind of pipe but will last a life-time if used in a proper manner. It is much better to keep these boxes in the shop, if possible; they can be piled on the top of each other and take up very little room. The boxes for pipes 2½ in. to 4 in. diameter should be similar to that shown in Fig. 1. Table I. gives the dimensions of various sizes of boxes. The first size is to take 4-in. pipe flanges in the body of the box, also elbows in the pockets. It is capable of being extended to take elbows over the usual standard, also tee pipes. Flanges are necessary on the whole length of the box, so that cramps can be used to hold down the chaplets. Snugs are used, of course, to cramp the top down to the bottom; ordinary cast-iron cramps and wood wedges will do for this purpose. The style of lever shown in Fig. 2 is very suitable and light for lifting off the box top.

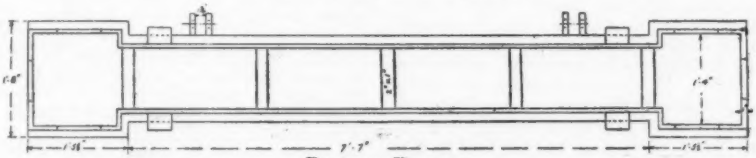
TABLE I.—*Size Details of Moulding Boxes for Jobbing Pipes.*

	2½ in. × 4 in. boxes.	5 in. to 6 in. boxes.	7 in. to 10 in. boxes.
Length	10 ft. 6 in.	10 ft. 6 in.	10 ft. 6 in.
Pockets	12 in. × 12 in.	16 in. × 15½ in.	20 in. × 20 in.
Depth of box ..	6 in.	7½ in.	10 in.
Holes in side pockets	6 in. dia.	7½ in. dia.	10 in. dia.
Holes in end pockets	6 in. dia.	7½ in. dia.	12 in. dia.
Bars (centres) ..	6 in.	7 in.	8 in.
	Handles and hinges.	Handles and hinges.	Swivels (1¼ in. dia.) and pins (1 in. dia.) in place of hinges.

Width of boxes in body according to diameter of pipe flanges allowing ½ in. of sand at each side of largest pipe.



PLAN AND ELEVATION OF TOP PART.



BOTTOM PART.

FIG. 1.—DESIGN OF BOX FOR 6-IN. JOBBING PIPES.

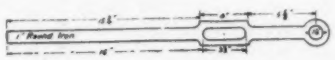


FIG. 2.—LEVER FOR LIFTING OFF TOP BOX.

The next size of box we should arrange would be to take pipes from 5 in. to 6 in. inclusive. These boxes will do made to use with hinges, thereby saving pins, crane work, room, time, and trestles.

The next size would be 8-in. boxes, with bars, pins, snugs, swivels, holes for extending, etc. These would take all pipes from 7 in. to 10 in. inclusive. Of course, if one can standardise tees and elbows,

* Abstract of Paper read before the Lancashire Branch of the British Foundrymen's Association, January 9, 1915, Mr. J. Simkiss in the chair.

say, 7 in. by 7 in. or so on, one would put the patterns on plate, make boxes to suit, and make up a 9-ft. elbow by using, say, one of these and an 8-ft. 5-in. straight length.

The next size would be to take pipes 11 in. and 12 in. This size of box should be pinned like that for 7-in. to 10-in. pipes, and have swivels to turn over on trestles; also be flanged from end to end. Pipes of larger size require boxes to be built up from plates. If the boxes described are made and used the saving in expense will soon be noticed in any foundry which makes pipes in quantities.

Take a shop which has a quantity of pipes coming in every now and then. In comes all varieties of boxes from the yard; the pipes are bedded on the floor, and covered by these top boxes, perhaps with a bar or two smashed out every time, until the top is simply a weak frame. All the weights in the shop are required to hold them down. Probably there are not half enough, so moulders have to wait until these are cast, so that they can use the bars, packing, weights, etc., and wedge the chaplets, causing quite a lot of unnecessary overtime, thus adding expense to the job. All this could be avoided by the proper designing of a few pipe boxes.

As against all the labour and trouble of bedding in the floor, when hinge boxes are used, you hinge the top part back on to some support, dig out the bottom, bed in the pattern, using the joint of the box to give a good guide to half of the pattern, put the top on, ram up, hinge off, finish and core the job, turn on the top, cramp both the chaplets and the joint, and prepare for casting. The mixing up and lifting of the casting will take about half the labour, and the boxes can be closer together. There is no need to twist the ladle over the top of weights, and in casting you will not have to call someone to move the weights on to one side so that you may get at the runner.

Patterns.

The patterns require to be good ones if any neatness in the appearance of the pipes is desired, and this also aids the moulder in production. The 2½-in. to 8-in. sizes should be turned iron lengths, with sockets for the standard lengths, and prints turned up to the required size. The patterns should be long enough to project through the ends of the boxes, with holes drilled in the ends to enable the moulders to twist the pattern with a bar previous to lifting the top half of the box, and also withdrawing the pattern. Of course, a hole would be cast through the pattern to reduce the weight and also enable the pattern to be lifted. Iron flanges could be turned for the necks of the standard lengths. If desired, these would have to be drilled and tapped to enable them to be used. When elbows or any other jobbing pipes are required, body flanges have to be used on the pattern and the prints, made up with make-up templates. The elbow patterns could be made in halves, dowelled so that the two halves would come exactly true to each other; the print on the iron pattern could be made up by slipping a shell over the part near to which the elbow is set. Branches are also set on the side of the pattern. All flanges should be in halves except bottom branch flanges, which will do whole. To set these elbows and branches set-squares and straight-edges require to be used; also two articles not usually in the possession of a large number of moulders, viz., rule and level. These articles are absolutely necessary to a successful pipe moulder. A level with a glass at right angles to the top level is very useful to set up flanges square. A staff containing the size, length, position of branches, and number of pipe to be made, is given to the moulder so that he can proceed with the job; but I am sorry to say that many moulders cannot read from the sketch where the branches should be put on the pipe, especially if a plan of the pipe be given.

Patterns over 8 in. diameter would be better turned in halves, and should be of the same design as just described, except for the fact of being in halves. They will be better to handle, and will give the moulder his half-way line, besides enabling him to get a good lift with his top.

Core Barrels.

Core barrels should be at least 11 ft. long, made of wrought iron up to 6 in. diameter and of cast iron over 6 in. and up to 12 in. diameter. They can be withdrawn shortly after the pipe is cast, by means of a steel bar inserted in a hole drilled through one end of the barrel, which should also have a collar on so that the end will not break away so soon. The barrels must be perforated all along to allow the gases to escape. There will also be required strickles, plates, loose irons, loose hay and straw bands in the making of the cores; also a board and trestles to strike up the loam cores on barrels. Great care should be taken in the preparing of the loam and clay so that no scabbing will take place from the core during the process of pouring the metal. A good cohesive yellow clay, weakened with about equal parts of old sand, and ground for a few minutes, will serve the purpose well. Loam should consist of five parts red sand, four parts old sand, and two parts horse manure, just ground for a minute or two, taking care that the loam does not get ground too much. Should that occur there will be trouble on the top of the core with all pipes poured. If these rules are carried out and the cores are well dried there need be little fear of core scabs.

Facing sand should consist of 6 parts open red sand, 2 parts road sand, 2 parts old sand, and 1 part coal dust. This should be well mixed up and trodden by the sand mixer, no grinding being done. In the top half of the mould dry black sand is quite enough, except just round the flanges and around the gates. The gating can be done on the top of the pipe, with round gates, or in the side with flat gates, or in the end with V gates. Perhaps the end gates are the safest method with pipes above 8-in. or 9-in. cores. Chaplets should be used in preference to nails, as they are more reliable, being cast on the pipe so that the stem of the chaplet can be riveted round, to prevent leakage of water, air or steam under pressure.

Pouring.

All pipes should be poured as hot as possible, so that a clean bright casting be assured. Should there be any likelihood of the iron showing sink holes on the flanges the risers could be placed about 12 in. from the flanges, so that the rise head would not help to keep the metal molten too long, and would help to prevent leakage behind the flanges. Cores for bolt holes in the flanges can be placed in their position by the aid of a template, this being believed among pipe moulders to be cheaper and better than blocking the flanges with cores.

Metal.

While bearing in mind the necessity of cheapness in the production of pipes, and also the fact of using up old scrap, a good, cheap and fluid metal could be obtained for casting pipes by working to the following analysis, averaging scrap as containing about 2.5 per cent. carbon, 2 per cent. silicon and 1 per cent. phosphorus:—Total carbon, 3.2 per cent.; silicon, 3 per cent.; phosphorus, 1.1 per cent.; manganese, 0.6 per cent.; sulphur, 0.3 per cent. The

above has been tried with success, but, of course, is not recommended to anyone who wishes to cast up the shop with one mixing, and who has to cast heavy lumps or castings with bosses on, etc.

All pipes should be tested to double their working pressure before leaving the works' yard, and providing the pipes are cast clean and free from defects they should stand considerable pressure. Any pipe up to 6 in. diameter bore, $\frac{3}{8}$ in. metal, should easily stand 300 lbs. as test pressure without sign of a leak, and on a 2½-in. pipe, 7/16 in. metal, 700 lbs. test pressure has been tried successfully. Pipes from 2 in. up to 6 in. which are cast $\frac{3}{4}$ in. metal and bracketed behind the flanges will require special attention and metal to prevent leakage behind the flanges.

Special Jobs.

For pipes which only require one or two castings from the pattern, and which have a large sweep, or are of odd bore, it is obvious that to make a wood

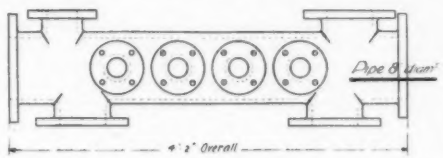


FIG. 3.—FLANGED PIPE WITH NUMEROUS BRANCHES.

or iron pattern would be out of the question, so we have to use the core for a pattern by strickling a thickness on the core diameter and stripping it off again after the mould is rammed up. This is rather expensive, but unless the expense can be afforded

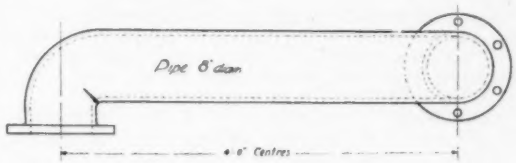


FIG. 4.—DOUBLE ELBOW PIPE.

and bringing the gases through a coke bed underneath the elbow, jointing the two cores in the straight length, both of which cores would have to be strickled from plates. Fig. 5 shows three 3-in. diameter pipes which can be made in one 4-in. hinged box, from the following:—Iron pattern, body flanges, elbow-end pattern and branch. The position of the pipes in the bottom half of the box is shown.

The following simple rules should be observed in making pipes:—Keep the setting of the flanges correct; use dry black sand for pipe tops; wedge all chaplets and barrels carefully; use hot metal and keep up gates; keep all vents from cores open and work to dimensions given on pipe staffs.

In the coring of pipes the moulder will have to be very careful about getting the centre of the mould for his core, particularly with $\frac{3}{8}$-in. metal pipes. A slack chaplet wedge, or a chaplet out of sweep or position will sometimes cause a pipe core to move say, $\frac{1}{8}$ in., leaving the pipe $\frac{1}{4}$ in. metal on top. A pipe like this would be very dangerous if it were included in any installation. Also all chaplets should be tinned, and not rusty. If the chaplets do get rust on them it is best to coat them with red lead, turpentine and raw linseed oil.

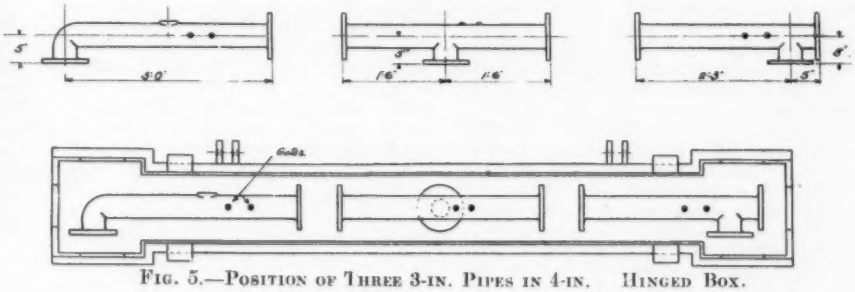


FIG. 5.—POSITION OF THREE 3-IN. PIPES IN 4-IN. HINGED BOX.

for a skeleton pattern it is the best method to adopt. To make a pipe like that in Fig. 3, we should first bed in the straight body pieces, with the end flanges on, and ram up to joint. We should then select the side of the pipe with the largest number of branches on, and have this for the bottom, leaving the end flanges in the same; then cut out the body to the required depth, and, using the end flanges as a gauge, proceed to level the straight-edges, one at each end, to the required depth, and by their aid make a facing bed, so that the bottom flanges could be laid on at their respective distances and so set all six at one operation, covering them with loam cakes. If the branches were at unequal distances from the body of the pipe, which seldom occurs with delivery pipes, blocked out branches would have to be used, but the former method is much preferable if at all possible.

With a pipe of the design shown in Fig. 4 we should have to make the elbow looking down as shown, setting the pipe by means of the body part,

Discussion.

MR. P. WALKER said there were certain points on which he ventured to differ from the statements made by Mr. Hogg. Some of his remarks applied rather to standard pipes than to jobbing pipes. Turned patterns were all right for standard pipes, but not for jobbing pipes. Mr. Hogg also stated that the patterns were better in halves; that might be so if they had a good place in which to keep them, and a good many men to work with them, but not otherwise. When an elbow pattern had been somewhat knocked about it was worse than a standard pattern. He also said better joints would result from having the patterns in halves, but they must be careful to have them fit, and after a few years' use they were apt to wear and they might then be a little bit out.

MR. CORDINGLEY asked if Mr. Hogg found any difficulty in bracketing? He would be interested to hear his opinion on that point. In regard to the cramp, he took it that was made wider than

the box, and then used as a twist.

The CHAIRMAN was inclined to agree with the observations of the first and last speaker. With regard to standard pipes, they could easily talk a very long time on the methods of making them. The first note he had made as the Paper was being read, concerned the hinge boxes; for his part he could not advocate them, for a box which had been in work a considerable time would wear, with the result that in the case of many pipes they would get one side of the box lifted. Small boxes for small pipes worked extremely well. He would advise Mr. Hogg to leave loose ends in the boxes, and have as many holes in them as he liked. At his works the boxes were made with loose ends, and he thought it was an improvement. Those who had had much experience had found a free top box the best. As to making standard pipes, he believed they would have to go a long way to beat the pipe-making machine.

MR. HOGG, in replying, said if they could get a pipe machine for making jobbing pipes, he should be very glad to see it. In the case of boxes in halves, they could always be set true, but, of course, they would not last for ever.

The Determination of Phosphorus in Phosphor-Bronze.*

BY E. W. HAGMAIER.

Phosphor-bronze is one alloy of which the chemist cannot say much regarding the phosphorus content until he has obtained the precipitate of phosphorus. Alloys called phosphor-bronze may contain anywhere from zero to 1 per cent. or more of phosphorus. An experienced analyst may get somewhat of an idea as to whether the phosphorus is high or not by observing the condition of the metastannic acid in dilute nitric solution. If the phosphorus is ½ per cent. or so, the metastannic acid will keep the original form of the drillings, after the copper, lead, etc., have gone into solution. The metastannic acid will be a greyish black when on the filter paper.

The writer has had occasion to analyse numerous phosphorus alloys, and while doing so worked out an accurate and rapid method which will follow after a brief review of some of the older methods. One method which is used a great deal is as follows:—Dissolve 1 gramme of the alloy in 30 c.c. of (1-1) nitric acid, and evaporate to a paste. Take up with a little dilute nitric and hot water, and boil to dissolve the copper, lead etc., which has separated out. Remove from the hot plate and filter. The phosphorus is with the metastannic acid, provided there is sufficient tin present. The writer's experience has been that 6 per cent. to 8 per cent. of tin will hold up over 1 per cent. of phosphorus. This precipitate is ignited in a tared porcelain crucible, and the weight of the combined oxides of tin and phosphorus recorded. Potassium cyanide is then added to the crucible, and a fusion made. This converts the tin to metallic tin, and the phosphorus to potassium phosphate. The melt is then leached out with water, and the tin filtered off. The filtrate is made acid with nitric acid and boiled to drive off the cyanide. After all is driven off filter off any silica which may have come from the fusion attacking the crucible. The phosphorus is then precipitated in the usual way, and is determined and calculated to phosphorus pentoxide. This weight is deducted from the weight of the combined oxides already found, and the tin calculated.

This method will require at least two and one-half hours to get the phosphorus precipitated. It is necessary to run a blank on the potassium cyanide unless a special phosphorus-free cyanide is used. The amount of tin must always be sufficient to hold up all the phosphorus—that is, 6 per cent. to 8 per cent. of tin for 1 per cent. of phosphorus—otherwise it is necessary to add sufficient tin or some of the phosphorus will go in the filtrate with the copper, lead, etc.

Another method quite frequently used is to make a sodium carbonate and sulphur fusion of the combined oxides of tin and phosphorus, leach out with water, and filter off any sulphide of copper which may have been held with the tin. Make the filtrate slightly acid with hydrochloric acid, and filter off the sulphide of tin, boil off excess hydrogen sulphide, add nitric acid, evaporate to a low bulk, cool, add excess ammonia, then nitric acid, and precipitate the phosphorus. This method is by no means shorter than the previous one, and it is next to impossible to wash the sulphide precipitates free from phosphorus.

The writer conceived the idea of using cerium chloride as a precipitant for the phosphorus. The method used is as follows:—Dissolve one gramme of the bronze in 10 c.c. conc. hydrochloric acid and 5 c.c. conc. nitric acid in a tall-form 300 c.c. beaker. When solution is complete, add 150 c.c. of hot water, and 10 c.c. of a solution of cerium chloride (1 gramme cerium chloride, 25 c.c. hydrochloric acid, 200 c.c. water). Now add a solution of one part ammonium hydroxide and two parts water, from a burrette, stirring continually until the solution has a greenish-blue cast. This will require from 25 c.c. to 35 c.c. Now add 4 c.c. of acetic acid, and boil for five or ten minutes; remove from the hot plate and allow the precipitate to settle; this will require several minutes. Syphon off as much of the clear solution as possible, add 100 c.c. of hot water and again syphon. Repeat this washing six or eight times; with careful manipulation all but about 30 c.c. of the liquid can be decanted each time without disturbing the precipitate. After sufficient washing add 15 c.c. of nitric acid and 3 c.c. of hydrochloric acid and heat until the precipitate has all dissolved. When solution is complete, cool, add 5 c.c. (1-1) ammonia, and precipitate the phosphorus.

By this method the writer has been able to have the phosphorus precipitated in duplicate on three samples in an hour. When this method is used the tin is determined on a separate sample either electrolytic, by titration, or from the combined oxides.

The following results were obtained on actual phosphorus-bronzes, and on bronzes to which a known amount of phosphorus was added.

Bronzes with added Phosphorus.		Actual Phosphor-Bronzes.	
Phosphorus added.	Phosphorus found.	Average of five analyses.	Cerium chloride.
0.10%	0.084	0.068%	0.061
0.10%	0.089	—	0.065
0.10%	0.105	—	0.069
0.20%	0.208	—	0.070
0.20%	0.192	0.78%	0.765
0.20%	0.180	—	0.790
0.30%	0.306	—	0.788
0.30%	0.297	—	0.774
0.50%	0.500	0.79%	0.796
0.50%	0.492	—	0.793
0.50%	0.496	—	0.791
0.50%	0.490	0.65%	0.664
0.70%	0.711	—	0.672
0.70%	0.693	—	0.659
0.80%	0.806	0.813%	0.822
0.80%	0.792	—	0.827
1.00%	0.997	—	0.818
1.00%	0.984		
1.00%	1.008		
1.00%	0.990		

* "Metallurgical and Chemical Engineering."

The Oxygen Content of Open-Hearth Steel.*

By J. Allen Pickard and F. M. Potter.

The following work was undertaken as part of a systematic examination of the oxygen content of commercial steels with a view to collecting trustworthy evidence as to the amount of oxygen normally to be expected in good class material, and the limits within which it is desirable to restrict this element. The majority of samples examined in this work were courteously supplied to the authors by Messrs. S. Fox & Company, Limited, of Sheffield, and the Cargo Fleet Iron and Steel Company, Limited, of Middlesbrough. All the steels were made by either the acid or the basic open-hearth process, and, as far as can be judged from their analyses, they were generally of excellent quality. In the accompanying tables the samples are arranged in order of carbon content. The actual figures obtained for oxygen in duplicate analyses are given in the last two columns, and show the amount of agreement ordinarily obtained when using this method. Six of the results are reprinted from a former Paper and are included here for ease in reference.

TABLE I.—*Acid Open-hearth Steel.*

Sample.	Carbon per Cent.	Manganese per Cent.	Silicon per Cent.	Sulphur per Cent.	Phosphorus per Cent.	Oxygen per Cent. i.	Oxygen per Cent. ii.	
1	0·07	0·73	0·05	0·035	0·027	0·004	0·004	*Mean*— Carbon, 0·87 Oxygen, 0·011
2	0·79	0·68	0·210	0·030	0·060	0·020	0·021	
3	0·93	0·68	0·035	0·031	0·027	0·007	0·006	
4	1·08	0·62	0·024	0·033	0·022	0·012	0·016	
5	1·18	0·65	0·056	0·027	0·025	0·005	0·006	*Mean*— Carbon, 1·35 Oxygen, 0·007
6	1·33	0·42	0·140	0·030	0·024	0·004	0·007	*Mean of all*— Oxygen, 0·0096
7	1·55	0·49	0·100	0·027	0·026	0·010	0·012	

TABLE II.—*Basic Open-hearth Steel.*

Sample.	Carbon per Cent.	Manganese per Cent.	Silicon per Cent.	Sulphur per Cent.	Phosphorus per Cent.	Oxygen per Cent. i.	Oxygen per Cent. ii.	
8	0·10	...	...	...	...	0·038	0·036	
9	0·14	0·35	0·020	0·033	0·018	0·010	0·011	
10	0·20	...	...	...	...	0·031	0·026	
11	0·23	0·70	...	0·030	0·026	0·013	0·014	*Mean*— Carbon, 0·25 Oxygen, 0·021
12	0·26	0·49	0·120	0·030	0·031	0·003	0·006	
13	0·30	...	...	...	...	0·030	0·027	
14	0·32	0·42	...	0·051	0·020	0·040	0·041	
15	0·22	0·42	...	0·037	0·025	0·024	0·021	
16	0·25	0·50	0·122	0·027	0·020	0·005	0·008	
17	0·41	0·52	0·026	0·032	0·023	0·019	0·014	
18	0·44	...	...	...	...	0·029	0·025	
19	0·54	0·69	0·065	0·022	0·024	0·003	0·003	*Mean*— Carbon, 0·62 Oxygen, 0·021
20	0·55	0·97	...	0·055	0·011	0·016	0·017	
21	0·55	...	...	...	...	0·020	0·020	
22	0·61	0·74	...	0·053	0·021	0·038	0·044	
23	0·68	0·65	0·100	0·033	0·052	0·005	0·006	*Mean*— Carbon, 0·81 Oxygen, 0·011 *Mean of all*— Oxygen, 0·0189
24	0·75	0·30	0·025	0·025	0·022	0·025	0·026	
25	0·82	0·67	0·095	0·030	0·028	0·004	0·007	
26	1·00	0·67	0·035	0·016	0·025	0·006	0·007	

Consideration of Results.

It had been expected from the results published in the former Paper that it might be possible to discover some relationship between the oxygen and the carbon content, but the results quoted lend but little support to this theory. One most important conclusion to be drawn is that it is possible to make all kinds of open-hearth steel, even low-carbon low-silicon basic (No. 9), practically free from oxygen—containing only 0.010 per cent. or under. That some steels are made containing more than that amount is however, abundantly shown by the other results, and it is to be observed that the cheaper steels contain higher oxygen.

Acid open-hearth steel is generally admitted to be of better quality than basic open-hearth, and it has been suggested that this is due to the higher oxygen content in basic steel. In the tables all the high-oxygen steels (that is, over 0.020 per cent.) except one (No. 2) are found in the basic group, so that the evidence does support the conclusion that basic steel is higher in oxygen. It is to be noted, however, that only two of the basic steels are higher in carbon than the lowest of the acid group, and no marked difference is to be noted in those samples comparable in carbon content; indeed, No. 2, and acid steel, is higher in oxygen than Nos. 23, 25, and 26, which are basic.

An interesting question is raised by the fact that the samples that must have received most hot-working are all high in oxygen. Nos. 14 and 15 were taken from two fishplates, No. 22 from a rail, while the other samples were from fair-sized billets. The possibility that the oxygen content may vary after the steel has solidified has not hitherto been considered, so far as the authors are aware. It must be borne in mind, however, that these steels, as judged from their other constituents, were not of the very highest quality, and that Nos. 8, 10, 13, 18, and 21, which are all high in oxygen, were of cheap make.

The results obtained by previous workers are very scanty. The authors have only found the figures given by Cubilio, who gave for acid open-hearth steel in the ladle, 0.004 per cent. of oxygen; and R. H. McMillen, who has published the following data :—

Sample.	C.	Mn.	Si.	S.	P.	O.	
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent. i.	Per cent. ii.
Basic O.H. ...	0.07	0.16	0.08	0.019	0.008	0.112	0.115
Basic O.H. ...	0.08	0.22	0.01	0.016	0.008	0.079	0.072
Basic O.H. ...	0.56	0.69	0.03	0.010	0.046	0.043	0.042

The method of reduction in a current of hydrogen, used by both workers, is open to several objections. With regard to McMillen's figures, it is noticeable that they are very much higher than those found for any steel examined by the authors. Taking this in conjunction with the fact that no steel examined by McMillen gave a lower value than 0.035 per cent. —even crucible steels, containing 1.17 per cent. and 1.14 per cent. of carbon, showing 0.035 per cent. and 0.045 per cent. respectively of oxygen—the authors are inclined to think that he must have been the victim of a systematic error not recognised.

A necessary and important consequence of low-oxygen content, if the determination of oxygen be made by the method used, is that the gas content must also be very low, at least in respect of carbon monoxide and dioxide. It was shown in the Paper

* Abstract of Paper submitted for reading at the Autumn Meeting of the Iron and Steel Institute

already mentioned that the oxides of carbon are reduced to water under the conditions of the experiment; consequently carbon monoxide and carbon dioxide contained in the steel, or given off from it on heating, are reduced and their oxygen appears in the final result.

If a steel gives off its own volume of carbon monoxide on heating, the oxygen in the gas represents an amount equal to 0.0091 per cent., a similar amount of carbon dioxide representing 0.0182 per cent. This conclusion is not invalidated by the fact that the steel is used in the form of fine turnings, as, although gas may be lost during the operation, the oxides of carbon are invariably practically absent from the gases obtained, which consist of nitrogen and hydrogen.

The World's Electric Steel Furnaces.

Particulars have recently been published* regarding the location, type, product and capacity of all the electric furnaces, operating or building, in the

TABLE I.—*Héroult Electric Furnaces, Operating or Building, January* 1, 1915.

Company.	Size of furnace in tons.†	Basic or Acid.	Current phase.	Charge.‡	Capacity per year, tons.
GERMANY.					
Richard Lindenberg	2½	B.	1	C. S.	2,250
Ditto	3	A.	1	O. H.	9,000
Bismarckhütte ..	1	B.	1	C.S.& O.H	1,200
Ditto	3	B.	1	Ditto	3,600
Ditto	*10*	A.	1	O.H.	24,000
Mannesmann ..	3	B.	1	C.S.	2,700
Deutscher Kaiser ..	7	A.	1	O.H.& B.B.	22,000
Ditto	7	A.	1	Ditto	22,000
Ditto	28	B.	3	Ditto	90,000
Ditto	7	A.	3	B.B.	12,000
Ditto	7	B.	3	F.M.	—
Thyssen	7	A.	3	B.B.	12,000
Ditto	7	B.	3	F.M.	—
Rombach	3	B.	1	B.B.	10,000
Dortmunder Union .	7	B.	3	B.B.	25,000
Ditto	7	A.	3	Ditto	30,000
Ditto	*30*	B.	3	Ditto	120,000
Gelsenkirchen ..	4	B.	3	F.M.	—
TOTAL IN GERMANY : Operating, 16 ..	—	—	—	—	385,750
TOTAL IN GERMANY : Building, 2 ..	—	—	—	—	
LUXEMBURG.					
Felten & Guilleaume	*10*	A.	1	B.B.	40,000
AUSTRIA.					
Gebr. Böhler ..	4	B.	1	C.S.& M.M.	4,500
Ditto	*5*	B.	1	Ditto	5,000
Danner & Co. ..	2	B.	1	C.S.	1,500
Kärtnerische E. & S.	5	B.	1	C.S.	4,500
Brüder Lapp ..	6	B.	1	C.S.	6,000
Witkowitz	7	A.	3	O.H.	25,000
Ditto	2	B.	3	F.M.	—
TOTAL IN AUSTRIA : Operating, 6 ..	—	—	—	—	46,500
TOTAL IN AUSTRIA : Building, 1 ..	—	—	—	—	
HUNGARY.					
Kgl. Ungar. E. & S.	2	B.	3	C.S.	1,500
Manfred Weiss ..	*6*	—	—	C.S. & O.H	9,000
De Litzpak	*3*	—	—	Ditto	4,500
TOTAL IN HUNGARY : Operating, 1 ..	—	—	—	—	15,000
TOTAL IN HUNGARY : Building, 2 ..	—	—	—	—	
ITALY.					
Mannesmann ..	6	B.	1	C.S.	5,500
Ditto	6	B.	1	Ditto	5,500
Ditto	15	A.	3	Ditto	15,000
Ditto	15	A.	3	Ditto	15,000
TOTAL IN ITALY : Operating, 4 ..	—	—	—	—	41,000
SWITZERLAND.					
G. Fischer	1	B.	1	C.S.	2,500
FRANCE.					
Ste. Electrometallurgique Francaise	3	B.	1	C.S.	2,500
Saut du Tarn ..	5	B.	1	Ditto	4,500
Ste. de la Basse Loir	5	B.	1	Ditto	4,500
Aciéries de Caen ..	*5*	—	—	B.B.	15,000
Ditto	*5*	—	—	Ditto	15,000
Ditto	*25*	—	—	Ditto	75,000
Ditto	*25*	—	—	Ditto	75,000
Aciéries electrique de Paris et de la Seine	2½	—	—	C.S.	3,000
TOTAL IN FRANCE : Operating, 2 ..	—	—	—	—	194,500
TOTAL IN FRANCE : Building, 6 ..	—	—	—	—	

TABLE I.—*Héroult Electric Furnaces, Operating or Building, January* 1, 1915—(*continued*).

Company.	Size of furnace in tons.†	Basic or Acid.	Current phase.	Charge.‡	Capacity per year, tons.
ENGLAND					
Edgar Allen ..	3	B.	1	O.H.	7,500
Edgar Allen ..	*3*	B.	1	O.H.	7,500
Vickers	2½	B.	1	C.S.	3,000
Thomas Firth ..	2½	B.	1	C.S.	3,000
Vickers	6	B.	1	C.S.	9,000
Lake & Elliott ..	2	B.	1	C.S.	2,000
Skinningrove ..	*15*	B.	3	T.M.	45,000
TOTAL IN ENGLAND : Operating, 5 ..	—	—	—	—	77,000
TOTAL IN ENGLAND : Building, 2 ..	—	—	—	—	
BELGIUM.					
Ste. du Hainaut ..	*5*	B.	1	O.H.	15,000
Ste. d'Ougrée ..	5	B.	1	O.H.	15,000
TOTAL IN BELGIUM : Operating, 1 ..	—	—	—	—	30,000
TOTAL IN BELGIUM : Building, 1 ..	—	—	—	—	
RUSSIA.					
Obuchow	3½	B.	1	O.H.	10,000
Makiewka	3½	B.	3	O.H.	10,000
Sormowo	3½	B.	1	O.H.	10,000
TOTAL IN RUSSIA : Operating, 3 ..	—	—	—	—	30,000
SWEDEN.					
A. G. Elektriska Stal.	3½	B.	1	C.S.	3,000
Akt. Liungly Stalgjutery	2½	—	—	C.S.	3,000
TOTAL IN SWEDEN : Operating, 1 ..	—	—	—	—	6,000
TOTAL IN SWEDEN : Building, 1 ..	—	—	—	—	
CANADA.					
Electric Steel & Metals	6	B.	3	C.M.	6,000
UNITED STATES.					
American Steel & Wire Co.	12	B.	3	M.M.	25,000
General Electric Co.	5	B.	3	C.M.	3,000
General Electric Co.	2½	B.	3	C.M.	1,500
General Electric Co.	1	B.	3	C.M.	500
Halcomb Steel Co. .	4	B.	1	M.M.	5,500
Crucible Steel Co. ..	5	B.	3	M.M.&C.M.	5,000
Treadwell Eng. Co. .	2	B.	3	C.M.	1,700
Lebanon Steel Fdry.	1	B.	3	C.M.	1,200
Latrobe El. Steel Co.	6	B.	3	C.M.	6,000
Firth Sterling Co. ..	3	B.	3	C.M.	6,600
Firth Sterling Co. ..	3	B.	3	C.M.	6,600
National Malleable Castings Co. ..	5	B	3	M.M.&C.M.	8,000
Ditto	5	B.	3	M.M.	24,000
United Steel Co. ..	6	B.	3	M.M.&C.M	8,000
Electric Steel Co. ..	3	B.	3	C.M.	3,600
Buchanan El. Steel Co.	3	B.	3	C.M.	3,600
Illinois Steel Co. ..	15	B.	3	M.M.	30,000
Illinois Steel Co. ..	4	B.	3	C.F.M.	6,000
TOTAL IN UNITED STATES : Operating, 15 ..	—	—	—	—	141,200
TOTAL IN UNITED STATES : Building, 3 ..	—	—	—	—	
GRAND TOTAL IN THE WORLD : Operating, 56 ..	—	—	—	—	1,015,450
GRAND TOTAL IN THE WORLD : Building, 19 ..	—	—	—	—	

* "The Iron Age."

† Figures in italics represent furnaces building.

‡ C.S.=Cold scrap. O.H.=Open-hearth Metal. B.B.=Basic Bessemer Metal. F.M.=Ferro-manganese. M.M.=Molten Metal. T.M.=Talbot Metal. C.M.=Cold Metal. H.M.=Hot Metal.

TABLE II.—*Girod Furnaces in Operation or under Construction, January 1, 1915.*

Company.	Size of furnace in tons.	Basic or acid.	Current phase.	Charge.	Capacity per year, tons.
FRANCE.					
Compagnie, Paul Girod, Ugine, Savoy ..	8 to 12	B.	3	C.S.	19,500
Ditto	8 to 12	B.	3	C.S.	10,500
Ditto	2½ to 3	B.	3	C.S.	3,150
Ditto	2½ to 3	B.	3	C.S.	3,150
Ditto	1½	B.	3	C.S.	1,575
Ditto	20 to 25	B.	3	C.S.	20,000
Marrel Freres ..	5	B.	1	C.S.& H.M.	—
TOTAL IN FRANCE : Operating 7 ..	—	—	—	—	48,875
ENGLAND.					
Rubery, Owen & Co.	3	B.	3	—	3,150
GERMANY.					
Stahlwerk Becker ..	3	B.	1	C.S.& H.M.	3 150
Gutehoffnungshütte	3	B.	1	H.M.	9,000
Krupp	12	B.	3	C.S.	12,600
Krupp	5	B.	3	F.M.	—
Oberschlesische Eisen Indust.	8	B.	3	C.S.& H.M.	8,400
A. Stotz & Co. ..	1	B.	1	C.S.	—
TOTAL IN GERMANY : Operating, 5 .. Building 1 ..	—	—	—	—	33,150
AUSTRIA.					
Steirische Gusstahlwerke	2	B.	1	C.S.	2,100
Ternitzer Stahl & Eischwerke-von-Schoeller ..	5	B.	1	C.S.	5,250
TOTAL IN AUSTRIA : Operating, 2 ..	—	—	—	—	7,350
HUNGARY.					
Diosgyorer Kal.Eisen Stahlwerke ..	2	B.	1	C.S.	2,100
SWITZERLAND.					
Oehler & Co. ..	2	B.	1	C.S.	2,100
Oehler & Co. ..	2	B.	1	C.S.	2,100
TOTAL IN SWITZERLAND : Operating, 1 .. Building, 1 ..	—	—	—	—	4,200
ITALY.					
Glo. Ansaldo ..	4	B.	3	C.S.	4,200
RUSSIA.					
Putiloff Works ..	6	B.	3	H.M.	18,000
BELGIUM.					
Société John Cockerill	3	B.	1	B.B.	9,000
UNITED STATES.					
Simonds Mfg. Co. ..	½	—	1	C.S.	525
Bethlehem	10	—	—	—	10,500
Bethlehem	10	—	—	—	10,500
Bethlehem	2	—	—	—	2,100
Washington Iron Works	3	—	—	—	2,100
Electric Steel Foundry	1	—	—	—	1,050
TOTAL IN THE UNITED STATES : Operating, 3 .. Building, 3 ..	—	—	—	—	26,775
GRAND TOTAL IN THE WORLD : Operating, 20 .. Building, 8 ..	—	—	—	—	156,800

world, the total being 213, or an increase of nearly 100 per cent. since early in 1910, and 50 per cent. since early in 1913. The tables, which are reproduced in part herewith, are based on data furnished by the technical department of the United States Steel Corporation, and are regarded as quite authoritative.

The number of miscellaneous electric furnaces other than Héroult, Girod or induction, building or operating in Europe, as shown by literature on the subject, is 62, comprising the following types :—Stassano, 15; Keller, 6; Chapelet, 5; Electrometals, 4; Gröndal, 2; Hiorth, 1; Nathusius, 2; Stobie (building), 4; Anderson, 4; Soderberg (building), 1; Rennerfeldt, 18.

TABLE III.—*Induction Furnaces in Operation or Course of Construction, January 1, 1915.*

Country.	Firm.	Size of furnace metric tons.	Type.†	Current phase	Charge.
U.S.A. ..	Deere & Co. ..	1.8	K.	1	C.
U.S.A. ..	General Electric Co.	0.2	K. ..	1	C.
U.S.A. ..	Eastern Metals Corp.	2.0	G.-S.-F.	1*	C. (Idle).
U.S.A. ..	American I. & S. Mfg. Co.	*20.0*	G.-S.-F.	1	L.O.H.
U.S.A. ..	American I. & S. Mfg. Co.	*20.0*	G.S.--F.	1	L.O.H.
U.S.A. ..	Crucible Steel Castings Co.	2.0	R.-R. ..	1	C.
England	Jessop & Sons ..	1.8	K. ..	1	C.
Germany	Bergische Stahlindustrie.	5.0	R.-R. ..	1	L.O.H.
Germany	Burbach-Hütte ..	3.5	R.-R. ..	1	L.O.H.
Germany	Ditto	3.5	R.-R. ..	1	L.O.H.
Germany	Ditto	3.5	R.-R. ..	1	L.O.H.
Germany	Becker, A. G. ..	2.0	R.-R. ..	1	C. and L.
Germany	Krupp	10.0	F. ..	1	C.
Germany	Krupp	12.0	F. ..	1	C.
Germany	Oberschlesische, A. G.	1.5	K. ..	1	C.
Germany	Peiner Walzwerk	4.0	R.-R. ..	3	Melting F.M.
Germany	Rochlingsche Stahlwerke.	12.0	R.-R. ..	1	L.B.B.
Germany	Ditto ..	*12.0*	R.-R. ..	1	L.B.B.
Germany	Ditto	1.5	R.-R. ..	3	L.B.B.
Germany	Ditto	4.0	R.-R. ..	3	Melting F.M.
Germany	Aachener Hüttenverein.	4.5	R.-R. ..	3	Melting F.M.
Germany	Elcken & Co. ..	3.0	R.-R. ..	3	L.O.H.
Germany	Rheinische Stahlwerke.	*1.5*	R.-R. ..	3	Melting F.M.
Austria .	Braun's Söhne ..	0.4	K. ..	1	C.
Austria .	Poldihütte ..	4.5	K. ..	1	L.O.H.
Austria .	Poldihütte ..	*13.0*	G.-S.-F.	1	L.O.H.
France ..	Marine et d'Homecourt.	3.0	R.-R. ..	3	C.
France ..	Chatillon, Commentry & Neuves-Maisons	1.5	M.	1	L.O.H.
Italy ..	Ferriere Gregorini	1.6	K. ..	1	C. and L.
Italy ..	Ferriere Pi montese.	*3.0*	R.-R. ..	3	L.O.H
Russia ..	Kronwerke, Slatoust.	*1.0*	R.-R. ..	3	C.
Sweden .	Domnarfvets Works.	1.5	K. ..	1	C.
Norway .	Stavanger Works	1.0	R.-R. ..	1	L.O.H.
Spain ..	Urigoitia e Hija .	1.5	K. ..	1	C.
Japan ..	Imperial Steel Works.	*3.0*	R.-R. ..	3	L.O.H.
Mexico ..	Ricardo Honey ..	2.5	R -R. ..	3	L.O.H.
TOTAL: —Operating, 28 ; building, 8.					

* Brass. †K = Kjellin. G.S.F. = Gronda-Siemens-Frick. R.R. = Röchling-Rodenhauser. F. = Frick. M. = Montlucon.

It will be seen that the Héroult furnace leads all types in number of installations, with 75 in the world, the induction furnaces as a class coming next with a total of 36. Of the total of the 213 furnaces in the world, active or building on January 1, 1915, 174 are of the arc type, 37 induction, and two combined arc and induction.

Development in the United States and Canada in the last two years has been distinguished by the entrance into the field of three types of furnaces not operating in Europe, the Snyder, the Hering and the special furnace of the Moffat-Irving Steel Works, Limited, Toronto, Ontario, in which castings are made direct from the ore.

What is regarded as the largest electric furnace plant in the States, making steel, is the one nearing completion at the works of the American Iron and Steel Manufacturing Company, Lebanon, Pa. This installation consists of two 20-ton induction furnaces for refining steel from the Company's new open-hearth department.

TABLE IV.—*Electric Furnaces, other than Héroult, Girod and Induction, in the United States and Canada.*

Company.	Type.	Size, tons.	Acid or basic.	Phase	Charge	Daily capacity per 24 hrs., tons.
Moffat Irving Steel Works, Ltd. ..	—	1.1	B.	3	C.S.	—
Ludlum Steel and Spring Co ..	—	2.1	B.	—	C.S.	—
Niagara Electric Steel Corp.	Hering	0.5	—	—	—	—
Firth Sterling Steel Co.	Stassano	1.4	B.	3	C.S.	—
Warren Steel Casting Co.	Stassano	1.0	B.	3	C.S.	—
Warman Steel Casting Co.	Stassano	1.0	B.	3	C.S.	—
Hess Steel Casting Co.	Stassano	1.0	B.	3	C.S.	—
Chicago Electric Casting Co.	Snyder	1.4	B.	1	C.S.	12
Erie Malleable Iron Co.	Snyder	1.4	A.	1	C.S.	20
Crucible Steel Casting Co.	Snyder	1.0	A.	1	C.S.	12
Otis Elevator Co. ..	Snyder	2.0	A.	1	C.S.	30
Otis Elevator Co. ..	Snyder	3.0	—	1	—	30
TOTAL: Operating, 10; Building, 2.						

TABLE V.—*Types of Electric Furnaces by Countries in* 1915.

Countries.	Héroult.	Girod.	Induction.	Stassano.	Keller.	Charlet.	Electrometals	Hiorth.	Nathusius.	Remmerfeldt.	Gröndal.	Special.	Total, Jan. 1, 1915.
Germany ..	10	6	16	[illegible]	1	—	—	—	[illegible]	—	—	—	46
Austria-Hungary	10	3	3	[illegible]	—	—	—	—	—	—	—	—	18
Switzerland ..	1	—	—	[illegible]	—	—	—	—	—	—	—	—	3
Italy	4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	—	—	—	—	—	—	22
France	[illegible]	[illegible]	[illegible]	[illegible]	—	—	—	—	—	—	—	—	17
England ..	1	1	4	—	—	—	—	—	—	3	—	—	16
Belgium ..	1	—	—	—	—	—	—	—	—	—	—	—	3
Russia	3	1	1	[illegible]	—	—	—	—	—	—	—	—	9
Sweden	[illegible]	—	1	—	—	—	[illegible]	—	—	[illegible]	—	—	18
Norway	—	—	1	—	—	—	1	—	—	—	—	—	[illegible]
Spain	—	—	1	—	—	—	—	—	—	—	—	—	1
Japan	—	—	1	—	—	—	—	—	—	—	—	—	1
Mexico	—	—	1	—	—	—	—	—	—	—	—	—	1
Brazil	—	—	—	—	—	—	1	—	—	—	—	—	1
Location not given	—	—	—	—	—	—	—	1	—	—	2	9	12
United States ..	18	6	6	4	—	—	—	—	—	—	—	7* =	41
Canada	1	—	—	—	—	—	—	—	—	—	—	1 =	2
World's total ..	75	28	36	19	6	5	4	1	2	18	2	17 =	213

* Includes 5 Snyder furnaces.

ENGINE CASTINGS.—In a Paper on the "Essential Principles of Engine Design," read before the Manchester Association of Engineers, Mr. Frank Foster included the subjoined table showing the standard composition of engine castings as practised by Messrs. Galloways, Limited:—

	Steam cylinders.	Frames.	Fly-wheels.	General.
	Per cent.	Per cent.	Per cent.	Per cent.
Total carbon	2.9 4	3.3	3.5	3.5
Combined carbon ..	0.9—0.95	—	0.37	—
Silicon	1.1—1.3	1.6	2.0	1.7—2.2
Manganese	0.6—0.9	0.65	0.4—0.5	0.3—0.4
Phosphorus	0.4—0.6	0.5	0.9	0.4—1.4
Sulphur under	0.15	0.15	0.15	0.15
Transverse load .. cwt.	35—46	34—38	30—33	29—32
Transverse deflection in.	0.5	0.5	0.35—0.45	0.3—0.5
Tensile .. tons sq in.	12—14	11—13	11—14	9—11

Considerations in Jig Making.

Discussing this subject before the Manchester Association of Engineers recently, Mr. M. R. Lawrence said that a jig was a device to aid, speed up and cheapen the making of parts which had to be alike. Most special jigs, fixtures, tools and gauges were made to lessen the cost of production, and a device might be said to pay directly if its cost, plus the cost of machining the quantity of parts, was less than without it; and indirectly, when the accuracy it gave to the pieces saved expense in the fitting shop, or increased the production of a particular machine tool. In order to decide what jig to make, and how to make it, an essential was to have a costing system which recorded the cost of the individual pieces, and also individual jigs, tools and gauges, etc., so as to know whether the estimated saving by a jig in the past had actually accrued. When the machine-shop put forward a request for some jig or tool which would lessen the cost of production, often time did not permit the management to go into the question closely. But when the saving to be secured on each piece, the number to be made, and the probable cost of the jig were known the matter could be settled easily. When the policy of the management as to the amount of saving to be capitalised became known, only useful suggestions were put forward. As a general rule, the author considered that a jig should not cost more than 75 per cent. of the saving it secured. The number and operation for which jigs, tools and gauges were used should be recorded on the drawing of the piece. This might be done either by records on the tracing, or by sticking a list on to the works' print. This would involve a small delay in issuing orders for jigs, but the great convenience to the works made it well worth while. These records of jig numbers on the drawings saved a great deal of time, trouble and money in the works, especially when replacements had to be made for designs no longer current. When a proper system was installed for dealing with this, no delays arose.

In jig design the most important point was, in the author's opinion, the correct location of "spotting point" of the piece. Often far too little attention was paid to this, and the larger the quantity to be handled the more important it became. A rule which should be rigidly observed was that the accuracy of any machining operations must never be increased beyond the requirements of the function of the part, in order that a jig or tool might be successfully located; no extra face or part should be machined for location purposes only. When a piece was not strictly to drawing and the inaccuracy was unimportant to the proper function of the part, it should pass on to the next operation. If, however, the inaccuracy became material because it affected the location in a subsequent jig, it called for special treatment, and unnecessary waste was made, or the jig put out of action for all or a percentage of pieces. The same principle applied to the location of thin castings with cores. They must be located from the correct places, so that if the cores had been misplaced the error was detected before an undue amount of work was put upon the castings.

The greater should never be located from the lesser; if this were done, slight errors multiplied, and conversely were minimised. When two operations had to be true to one another, the second should always be located from the first. If the first was generated from another face, it was wrong to locate the second from this face where great accuracy was required.

Moulding a Fan Casing.

By "Jay Bee."

Blower fans are common enough objects to foundrymen, but, nevertheless, the casings for these, when made in cast iron, form a very interesting job for the moulder. The writer will endeavour to describe the process employed in making casings for the well-known "Sirocco" fans. These are made with a green-sand core for two reasons; first and primarily for speed in knocking the core out after casting, as the thickness of metal is only $\frac{1}{16}$-in., and it will be readily understood that a heavy core made in dry sand could not be knocked out fast enough to allow the casting to contract, and would, consequently, result in a "sprung" casting. The second reason for using a green-sand core, also an important one, is that with a shell pattern the joints are tighter and less fins are produced, thus giving a much finer and better finished casting.

The pattern, as remarked, is of the shell variety, made in halves. The turnover board is placed on the floor and the bottom half pattern laid on. The board is made to fit up into the inside of the pattern, so that when the drag is turned over the board leaves the joint ready for making the core. The drag has a piece cut out of the side where the mouth-piece or discharge pipe comes, to allow the end of the core-iron to come through. Parting sand is put over the joint, and the core-iron bedded in with the end coming through the box side. The core is half rammed up, then the top half-pattern placed on and rammed up to the top, making a joint at the end of the mouth-piece, so that the core can be lifted out bodily.

The core-iron has a stud cast on (×, Fig. 1), which comes flush with the top joint of the core on the side where the biggest expanse of metal comes underneath. This having been done and parting sand placed over the joints, the top part is put on, and a stud rammed up in contact with the stud on the core-iron, this stud being wedged to a "keeper" in the top part. When all has been rammed up the top is lifted off, taking the top half of pattern with it by means of screws in the usual manner.

When this pattern is drawn out and the mould finished, attention is turned to the drag. If the core has suffered any damage in taking the top off that is remedied, and the top half of the pattern is put on, and all made good, when it is again removed. The lifters cast in the core-iron are then dug out, and the core lifted out of its place in the drag. Here it is as well to mention that the down runner comes right through the core, and the casting is run on the bottom, as shown. This is not only easier on the mould, but also does away with any chance of "cold shot" on the bottom, which was once a very common cause of wasters when run on the top or sides. The down gate is not dropped right through from head to bottom of the core, but is broken on the top joint of the core.

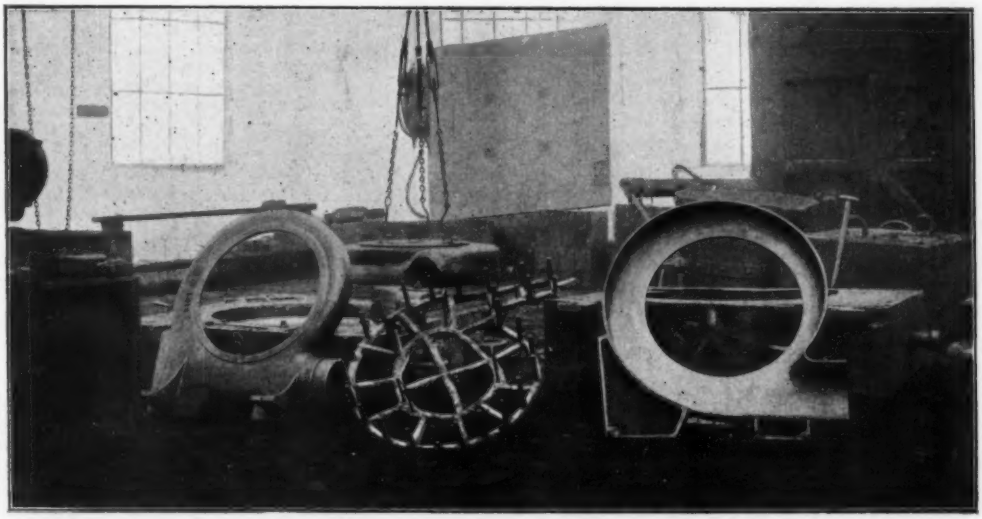


Fig. 1.—Pattern and Core irons for Fan Casing.

The core hangs on the crane while it is touched up where necessary, and is then lowered on to a bed of soft sand, covered with brown paper to prevent it adhering to the core. The bottom half of the pattern is then drawn out, and the gates cut, the mould finished, and the dry cores which cover the feet placed in position, after which the body core is laid in, being at its place as rammed up. The dry cores to cover the feet on the top part are not hung in the top, but are now placed directly on top of those in the drag. Fig. 2 shows the drag part of the mould and the main core, also the dry cores in position over one foot and the core print ready for the core to cover the remaining foot. The top part is now

closed on, and the end of the core-iron, which protrudes through the box, is "sconced" down to prevent the core rising.

After the job is cast and scrap removed, the top part is lifted off, and the hot casting turned out to break the core-iron and dig the core right out. If this is not done, the resistance which the core offers to the contraction of the casting would be too strong and result in a cracked casting. When the casting is cool it is fettled and sent to the machine shop.

Graded Coke for Foundry Use.

By Walter J. May.

In the foundry practice in most districts coke as it leaves the ovens is purchased and is broken and smashed up to get out the sizes needed for the different furnaces. Necessarily this causes a lot of waste, and as the fuel costs from 30s. to £2 per ton delivered, the money loss is a large one in most cases. Why should not the coke be broken and graded at the ovens to pass, say, 4 in., 3 in., 2 in. and 1 in. sq. mesh screens, taking out all passing a ¾ in. mesh, and using all between ¾ in. and ⅜ in. as fuel for anthracite and other slow-combustion stoves? If done at the coke ovens the cost would not be great and probably the saving of wasted small stuff would pay for all trouble, provided it was properly placed on the market.

Foundry proprietors would certainly prefer to get the size of clean coke most suited to their furnaces when this could be had clear of waste or labour, as from one to two shillings per ton would be saved by its use, while in the case of tilting furnaces and others using small fuel the saving would be more. In the Midlands, graded gas coke is supplied for some classes of manufacturing work, therefore why not foundry coke?

It can hardly be said that because graded coke is not asked for it would not sell, because few people ask for what is not on the market; but bring a useful article to public notice and it sells freely. A few years ago only large coke and "breeze" were sold at London gasworks, but now one gets large coke, broken coke and breeze, the broken grade free from dust and ready for the fire being rather higher in price than the unbroken grade. No one asked for the broken coke, but when it was offered they bought it in preference to that which was unbroken, and the same would be the case with foundry coke. If the makers offered it, users would purchase, but until produced it will not be asked for.

BORON IN ALUMINIUM BRONZE.—During the last year or two boron (in the form of a sub-oxide) has come prominently into notice as a deoxidiser for pure copper, in which capacity it has been found extremely valuable to the electrical industries, allowing the production of sound castings of pure copper. In the United States, however, a patent has recently been granted (to Edward D. Gleason) in regard to the use of boron in aluminium bronze. It is claimed that this alloy will not tarnish as readily as a bronze not containing boron and also has superior physical properties. In making the alloy, the aluminium is fused in a crucible under a layer of a mixture of three parts of fluorspar and one part of boracic acid. Boron fluoride is formed and reacts with the aluminium, and the boron thereby is reduced and absorbed by the aluminium, thus forming an alloy. This aluminium-boron alloy is used in the proportion of 10 parts to 90 parts of copper to make aluminium bronze, the metals being alloyed under a layer of charcoal and black oxide of manganese.

Fig. 2.—Drag Part of Mould and Cores for Fan Casing.

Melting Process and Furnace Construction for Malleable Cast Iron.

(*Continued from page* 98.)

Open-Hearth Furnaces.

The regenerative open-hearth furnace employed in steel-making unquestionably affords the best means of melting iron for malleable-iron castings, especially for the black-heart process; for a quicker and higher heat can be obtained with the least detriment to the metal, and the efficiency of the fuel is greater than in the air furnace or cupola, owing to the utilisation of the heat passing off from the hearth. A fuel ratio of one to six of iron can be obtained in good practice. As previously stated, the fuel has first to be gasified before being used, which latter fact involves the installation, operation and maintenance of a gas-producer—a subject which will be dealt with in a future article.

While the necessity of continuous operation has frequently been cited against the open-hearth, it should be remembered that comparatively small units can be worked economically, steel practice in this matter affording no criterion. Even a 10-ton furnace, however, operating continuously, gives a much greater tonnage than many foundries require, and for this reason the furnace in question is practically confined to large foundries. Despite these considerations, the writer believes the future will see a great development in the application of the small open-hearth furnace in malleable-iron foundries, for even with a higher relative maintenance cost due to smaller size, the advantages of the process where high-class metal is needed should render even a 5-ton furnace, if properly constructed, a practical unit. In a plant producing acid open-hearth steel and malleable cast iron (certainly not a common combination) there is the possibility of using the same furnace for alternate heats of steel and iron, and Moldenke mentions one works as adopting this practice.

Oil fuel also affords scope for considerable development in small open-hearth furnaces. Since these have been adopted with success in steel practice in units as small as 5 tons, there appears no reason why the same should not be done in malleable cast-iron plants.

The ideal open-hearth furnace is the tilting design, which allows the hotter metal on the top of the bath to be tapped first, the lower metal thus remaining longer for further heating. The cost, however, pre-

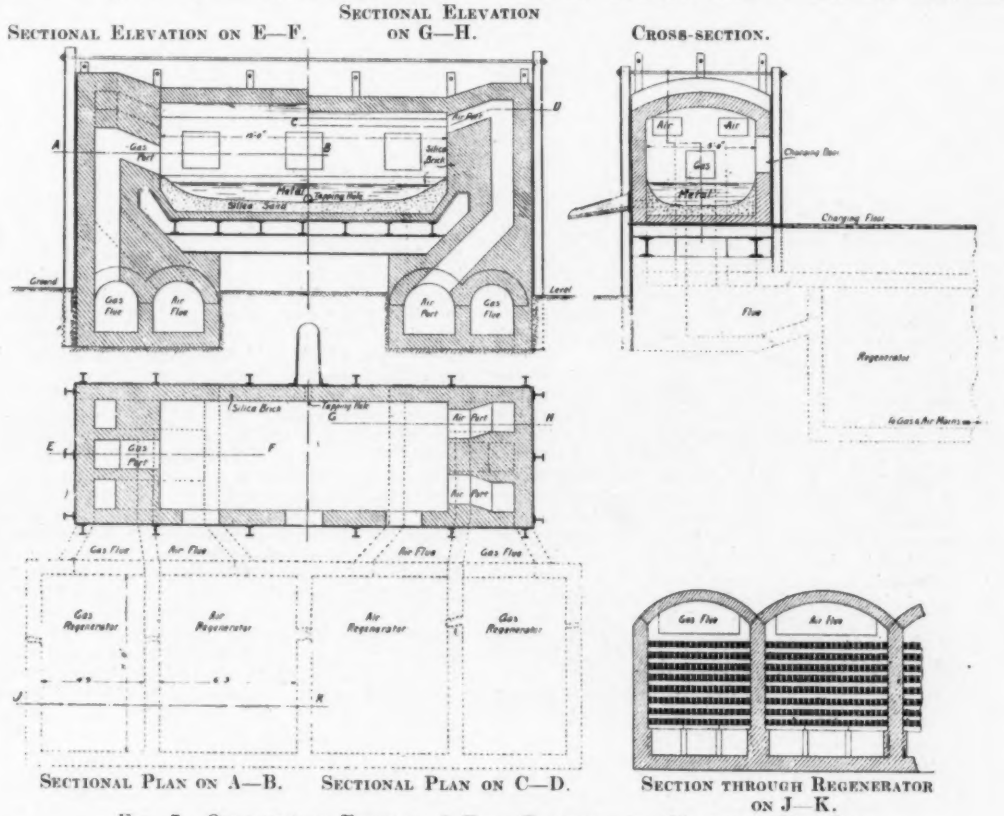


Fig. 7.—Open-hearth Furnace, 5 Tons Capacity, for Malleable Cast Iron.

cludes the use of this furnace in the present designs except for very large outputs and continuous operation. Where it can be adopted it certainly gives a more regular metal. In the ordinary open-hearth the top of the metal is hotter than that down on the bottom. Tapping, however, proceeds from the bottom, the top of the charge coming down some time later, until which time the oxidising action proceeds, and if the slag is taken off there is a direct contact with the gases, and the metal is damaged. For this reason the tilting furnace would be better, since it pours the top metal first. An arrangement, patented by Dr. Moldenke, provides three spouts, first taking off six or seven tons from the top, then the next six or seven tons below, then the breast is broken out and the rest of the metal got from the bottom.

In open-hearth practice it is advisable not to skim, but let the slag cover the iron, thus protecting it somewhat against oxidation.

Construction of Open-Hearth Furnaces.—The construction of this type of furnace is shown diagrammatically in Fig. 7. It consists essentially of:—(*a*) a hearth or combustion chamber containing the metal, into which air and gas are conducted separately, mingling for combustion on entering the hearth; (*b*) four regenerators or chambers filled with brick chequer-work through two of which pass respectively the air and gas for combustion, the other two receiving the spent hot gases of combustion from the hearth; (*c*) the flues connecting the regenerators with the hearth and the ports of the flues which direct the gas and air as required over the metal; (*d*) the necessary valves for controlling and directing the flow of gas and air through one or other set of the regenerators. The gas is supplied from a gas producer, the operation and construction of which will be discussed in another article.

The Body of the furnace consists of a shell or case of iron or mild-steel plates lined with best silica brick, carried on steel girders. In the earlier forms of open-hearth furnace the body was built directly upon, and was supported by the arches of the regenerators below, but this practice has been abandoned in good furnaces as the method of supporting on girders allows the circulation of air below, and the regenerator chambers may be placed close to the ends so that in the event of metal breaking through the bottom it cannot damage them. The casing of the body is in some designs rivetted together complete—a method of construction which has much to recommend it. Charging doors are suitably arranged on the platform side. To resist the disruptive influences of the expansion of the lining under heat, the walls are strengthened with supports braced across the top with tie-rods. The bottom plate may be of cast iron or mild steel.

The lining is the same as in the case of air furnaces—of silica brick for the sides and roof and silica sand rammed in and fused to form the hearth proper. The shape may be varied somewhat, and many designs have been tried; but the rectangular hearth is generally adopted as being the most efficient. Unlike the air-furnace roof, the roof of the open-hearth furnace is not dipped to reverberate the heat, but is built with an arched formation, and is kept well off the metal. This affords it a much longer life than when it is subjected to the cutting action of the flame. Some earlier designs adopted a dipping roof, but experience has proved the advisability of inclining the gas and air ports so that the flame impinges on to the metal and avoids the roof.

The Blocks or solid masses of brickwork between which the body of the furnace is placed contain the ports or passages through which the air and gas enter the furnace, and should be strongly constructed to resist the effects of the heat, which is naturally high at the point where the gas and air first mix and combust.

The Ports, their size, number and disposition have been the subject of much experiment and variation, and even now opinion is not unanimous on the matter. Some furnaces have (at each end) two air ports arranged above two gas ports; others have one large gas port with an air port on either side, and others, again, have two gas ports and three air ports. Probably the arrangement of two above two is preferable, as it allows of a more compact and stronger construction of the block; but the matter is a controversial one, and the decision affected by such considerations as the height of the roof, size of furnace, etc. As regards the relative sizes of the ports, it may be said that usually the area of the gas ports is as 5 to 6 or 7 of the air ports in small furnaces.

Regenerators.—The two regenerator chambers for heating the air are usually made larger than the two for the gas, the proportions being somewhat like 7 to 5. The actual size, of course, is controlled by the size of the furnace and the amount of gas and air to be passed through them. The essential requirement is ample surface for absorbing the heat of the expelled gases and imparting it to the incoming gases in turn. It should be remembered that gases are bad conductors of heat, and that surface contact of the bricks with the gases alone is effective. The regenerators are filled with brickwork, built in dry, and so arranged in chequer fashion that the gases are forced to traverse extended passages before passing on to the furnace ports. The design of furnace shown in Fig. 7 is a departure from the old practice in that the regenerators are set away from the hearth instead of being directly underneath. The advantages of this, if the space is available, have been mentioned.

Valves.—The operation of an open-hearth furnace requires two kind of valves—one to regulate the admission of gas and air (inlet valves), and one to control the direction of flow alternately from each end of the furnace (reversing valves). The inlet valves are usually of the mushroom type, and are regulated by screw and hand-wheel or similar means. The reversing valves are the more important, as they must effectively close one course while opening the other. They differ in design, but the common form is that known as the butterfly valve. The difficulty with the reversing valves lies in the fact that they are subjected to the effects of the hot gases first on one side and then on the other as they are reversed, and thus are liable to warp, and the leakage which results burns the valve seat. The valve consists of a cast-iron flap, swung on a spindle and operated by a lever or similar mechanism so that its position may be reversed.

Tilting Furnaces.—Reference has been made to the desirability of the tilting open-hearth furnace for malleable work. This furnace is essentially the same as the ordinary open-hearth, except that the body is arranged on rockers or rollers in such a way that a suitable mechanism (generally hydraulic) may be employed to tilt it for pouring. One feature—apart from the fact that the hot top metal is tapped first—which recommends this type is that the tapping hole, being above the metal surface, does not require ramming up with gannister, but is merely filled with sand, which is easily poked out with the bar at pouring time. Since the body of the furnace obviously must move at tapping time while the blocks and ports remain stationary, a slight space (up to ½ in.) is left between the face of the ports and the end of the body. The end is constructed with an opening which discloses the ports to the interior of the furnace when in

melting position, but which may partly close the ports during tilting.

Stack.—The expended gases, after passing through the regenerators and imparting thereto some of their heat, are discharged via the stack. The temperature of the gases passing to the stack is a good indication of the way in which the regenerators are working, and from this may be gauged whether the period between reversals (usually about 20 minutes) is correct. Reversal should take place when the temperature of the gases at the stack is a little over 900 deg. F., as at that heat it may be considered that the regenerator will absorb no more heat and is ready to impart its contained heat while the other side absorbs. As with other furnaces, the stack provides the draught for drawing in the necessary air.

Ratio of Gas and Air.—The ratio of air to gas should be such as gives a slightly smoky (reducing) flame. Perfect combustion of the gas, while being economical from the standpoint of gas consumption, is liable to involve oxidation of the metal; therefore, a quite clear flame should be avoided. The pressure of gas should not be great (Moldenke advises not more than 5 oz.), but just sufficient to allow proper mixing with the air and good combustion in the hearth.

The open-hearth furnace operation is as follows:—At the commencement of heating the furnace, gas from the producer and air are conducted respectively through the regenerators B and A, Fig. 8, and on entering the hearth or melting chamber they combust with the evolution of considerable heat,

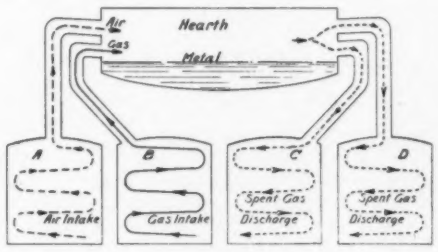


FIG. 8.—DIAGRAM OF OPERATION OF OPEN-HEARTH FURNACE.

which is largely imparted to the walls, roof and sole of the furnace. The spent gases, however, still retain a considerable amount of heat, and these on leaving the hearth pass through the ports at the opposite end and discharge by passing first through the chequer-work of the regenerators C and D, to which they impart some of their heat. By this means the heat of the waste gases is largely conserved in the brickwork of the regenerators. When this process has been continued sufficiently long to heat up the regenerators C and D, the valves controlling the flow of air and gas are reversed and gas is admitted to regenerator C, and air to regenerator D, the other regenerators, A and B then receiving the hot spent gases. The gas and air entering the hearth are heated on their passage through regenerators C and D, thus carrying back the heat conserved from the previous direction of operation. The spent gases, also, on passing out through regenerators A and B heat those in a manner similar to C and D in the earlier operation, so that when the latter have given up their heat sufficiently the process is reversed again, the air and gas then entering through A and B and being heated thereby. This process allows the air entering the furnace to be heated to about 1,000 deg. F., with consequent much greater heat of combustion in the hearth and quicker and hotter melting.

The larger sizes of steel-making furnaces are frequently charged with the aid of a special charging machine, but in the case of small sizes such as are used in malleable cast-iron foundries, hand-charging is usual.

In open-hearth furnaces designed for oil fuel, only two regenerators are required, as only the air is preheated in the chequer-work of the regenerators. A small oil-fired open-hearth furnace of special construction which should be particularly suitable for malleable cast iron is that designed by Mr. W. M. Carr, general manager of the Glenova, W. Va., plant of the Alloy Steel Casting Company, Wheeling, W. Va., U.S.A., where it was successfully used for light steel castings. The body of the furnace is cylindrical and entirely separable from the ports. To avoid the trouble with slag in lip pouring, the furnace is fitted with a nozzle and stopper, worked through the charging door and set in place long enough before tapping to permit of heating the stopper fittings. A special feature is that the body of the furnace may be carried to the moulds, pouring directly into them, thus giving a combined melting chamber and pouring ladle.

This furnace, which was illustrated in our issue of May, 1912, suggests itself as particularly useful for low-silicon mixtures, for not only can the refining by open-hearth methods be adopted, but the risk of chilling such mixtures is obviated by using the furnace body as the pouring ladle. The furnace at tapping time is lifted away from its port connections and the metal poured directly from it into the moulds. The flow is easily controlled by the nozzle and stopper. Unfortunately, definite data as to cost of operation are not available, but the designer and user says that it is less than that of the small Bessemer process or of the crucible process and that the figures compare well with standard open-hearth practice. Very little time is lost in the case of repairs, the furnace body being detachable, and spare lined shells for immediate substitution are kept ready, so that the damaged part can be removed and immediately replaced with a newly-lined one. The first cost of installation is moderate, and the operating costs are very low, as also are the costs of repairs, while also there is no ladle expense. Rapidity of operation is also claimed.

Oil-firing for open-hearth furnaces has come much into vogue in America, but it will probably be less readily accepted in this country unless better and more certain supplies of fuel are obtained. Though it may not, however, find wide application for large furnaces, there is a useful field for oil fuel where small outputs are required, on account of the convenience of handling and efficiency in melting.

UPWARDS of 550 of the directors, staff and employés of the British Aluminium Company, Limited, have enlisted to date. The names of the officers are:—Directors: Captain S. H. Pollen, A.D.C. to General Sir Ian Hamilton, and Captain R. W. Cooper, Rifle Brigade; head office: Lieutenant and Quartermaster P. Prentice, Royal Scots Fusiliers; Second-Lieutenant G. Mortimer, Connaught Rangers; Kinlochleven: Captain H. E. Webb-Bowen, Royal Engineers; Dr. Macdougal, Lieutenant R.A.M.C.; Second-Lieutenant H. Hilditch, Argyll and Sutherland Highlanders; Foyers: Second-Lieutenant F. E. Laughton, Cameron Highlanders; Burntisland: Second-Lieutenant, J. Duncan, H.L.I.; Milton: Second-Lieutenant D. H. Field, R.G.A.; Warrington: Captain A. H. Schultz, South Lancashire; Vigelands Factory: Lieutenant P. Chateau, 45th Infanterie, French Army. The Company have issued a handsome illuminated "Roll of Honour" with the names of the members of their staff and their employés who have joined the Colours.

Core-Boxes and Core-Making.

By D. Gordon, A.M.I. Mar. E.

(*Continued from page* 30).

Core-boxes for producing cores of varying dimensions are invariably made by the method known as "blocking up;" only in exceptional cases are they cut out of the solid material, as this latter method involves template work, which requires more time, labour and skill than the first-mentioned method. The "blocking-up" method consists in the combining of various pieces of material, which pieces are made to convenient sizes to facilitate their working up to shape. They are combined either by permanently fixing together the pieces by means of screws, glue and corrugated-iron cleats or fasteners, or by placing within framed-up boxes which receive the various pieces and retain them in position. This latter method of attaching or combining together core-box parts is, when the work is of a complicated nature, the most convenient to adopt, as it allows the various portions comprising the box to work off the core as loose units, reducing to the minimum the possibilities of fracturing, as the component parts are more easily removed and require less rapping, and may also be handled more freely. The chief disadvantage is the greater liability to variations of shrinkage, which affects the fit within the frame, allowing lateral movements detrimental to the production of accurate cores.

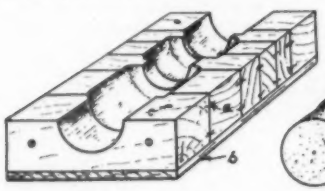


Fig. 57.

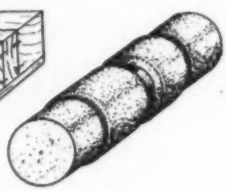


Fig. 58.

An example of a blocked-up box whose portions are combined together by means of screws, etc., is shown in Fig. 57, which is one-half of a core-box for the core Fig. 58. Here the box parts in their thicknesses allow as far as possible every facility for "straight through" cutting and the easy manipulation of those portions containing fillets. In the initial make-up of these boxes the various thicknesses required are obtained from the drawing in its full "setting out," and the pieces where the dowels (*c*, Fig. 57) are required are jointed and thicknessed up together to ensure accuracy for both half boxes. It, of course, does not follow that this method of allocating accurate positions by means of dowels is necessary, but it is the most commonly adopted and convenient method. The box parts when assembled are held together in the initial stage by means of screws only, and fixed to full battens or batten strips. The work is then marked out upon the joint faces of both core-box halves, being then dissembled and marked in the transverse direction. After cutting and finishing to size, the various parts are re-assembled, the joint faces where they abut against each other being glued and screwed together and further cohesion obtained by means of the cleats *a*.

The writer previously mentioned that this method of blocking up gives every facility for "straight through" cutting, but the term "cutting" is applied in its broadest sense, as it will be clearly understood from the example Fig. 57 that the entire box could be very expeditiously turned or cut to shape in the lathe. The principles involved, however, are applicable to any and every class of work, regular or irregular, turned or otherwise. In the majority of cases when the blocks forming the core-box proper are contained within frames, the class of core produced is of a more or less intricate nature, and as it is difficult to obtain relief by rapping and lifting only, it is preferable to work the various blocks as loose pieces, although this procedure in its entirety may not be altogether necessary. An example of a box of this type is shown in Fig. 59, which gives the joint view of the one half core-box for making a steam-chest core with its ports. The sections of the box at two positions are shown in Figs. 60 and 61, Fig. 62 being the view of the end block, which makes the smaller diameter core, and showing the method adopted to save both weight and material at those positions where the

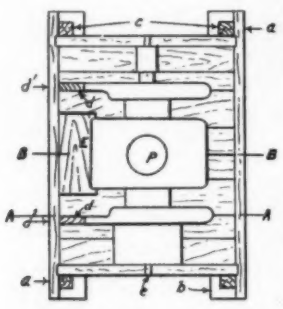
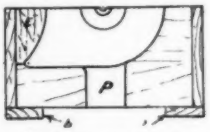
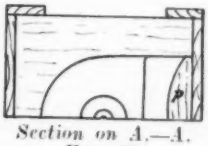


Fig. 59.



Section on B—B.
Fig. 60.



Section on A.—A.
Fig. 61.

full width or depth of material is not required. These frames are housed together and corner blocks (*c*, Fig. 59) receive the fixing screws, these latter at *a—a* being easily detachable so that the box-frame can be parted diagonally at these positions. When both halves of the complete box can in respect to depth be contained within a board's width, then the box frame is conveniently and more accurately made up as one, parted through by means of the saw and afterwards jointed together. The stretcher pieces *b—b* (Figs. 59 and 60) are the bearers of the various blocks and are permanently attached to their respective sides. The box ends, as at *c*, are cut out to receive the centre core-bar, which bar has attached to it the necessary wire for supporting the main body and its projections.

Owing to the pieces *d—d* and *E* being undercut in respect to the core's removal as a direct lift, they are of necessity required to work as loose pieces and their positions are defined by seatings (in the case of the piece *E*) cut into the pieces contiguous to its ends, the seating allowance being sufficient to give a firm bearing and incidentally allowing the required fillets to be formed out of the material

(Fig. 63). The loose pieces *d*—*d* (Figs. 59, 61 and 64) are screwed through the box sides in the directions d^1 (Fig. 59). This class of core is generally made up in halves and jointed together after being dried; but in some cases the half cores are rammed up within their respective half boxes and jointed direct previous to drying, the core being supported whilst the various blocks are relieved from the core. When made in halves the rammed-up half core contained within its box is inverted upon its core-plate, the frame of the box being then parted diagonally as depicted in Fig. 65, which shows the portion of the frame cleared from the blocks and in an inverted position. The various blocks are then cleared from the core as shown. The loose pieces *d*—*d* and *E* may conveniently be removed previous to inverting the core, and in some cases this method

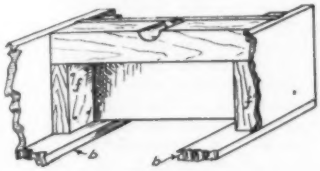


Fig. 62.

Fig. 63.

Fig. 64.

is preferable, especially when there are heavy overhanging projections, it being then necessary to part their surfaces and back up with sand to give support during the drying period.

Referring to the blocks *f*—*f* (Fig. 62) these are made fixtures to the respective box sides and serve as bearers for carrying blocks; they are applicable at any position when full-depth material is unnecessary.

When the core is possessed of only slight variations, especially in the smaller boxes, a method frequently

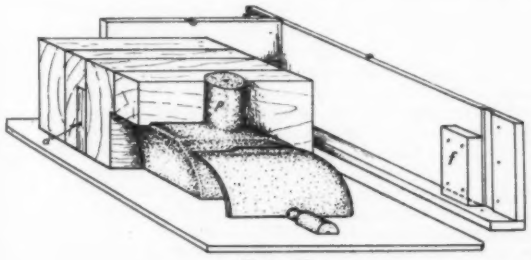


Fig. 65.

adopted in preference to cutting from the solid and template working is to bed in the variable piece, as shown in Fig. 66. These pieces are usually made from a harder material than the box body and in a transverse direction of grain. A seating *c*, Fig. 67, of any convenient size or shaping, is cut to receive them, being glued and screwed through the box as at *d* in the section at view *a*—*a*. Needless to say this is a common patching method when mistakes occur, or alterations are required in a box cut to shape from the solid material.

If the number of cores required be small and the cores be light and uniform in character, plaster-of-Paris boxes are made up, these being quickly and efficiently made, more especially if a duplicate of the required core can be quickly formed in wood, wax, etc. For example, if a box be required to produce cores as Fig. 58 a duplicate of this core could be easily turned up—preferably in halves—in the lathe. One-half of this duplicate core *b* (Fig. 68) is placed upon a flat surface and surrounded by a roughly-formed frame *a*, the extremities of *b* closely abutting against the frame ends. The inside of the frame and the surface of the piece *b*, are coated over with a fine film of any light oil. This oil is required as a parting medium, and should not be used to any excess as it tends to form blowholes and cause sharp corners to lose their definition. Within the frame and over the core's duplicate, plaster-of-Paris, mixed to the consistency of cream, is poured and allowed to set—a fairly rapid process. After setting, the frame *a* is removed, the cast-up plaster block inverted, and upon its surface at its defined position—which may be obtained by means of dowels—the remaining half duplicate core is placed. The frame *a* is then placed over so that a grip is obtained around

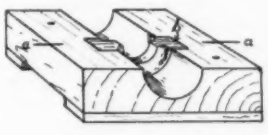
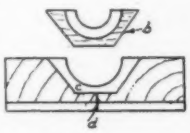


Fig. 66.



Section on a—a.

Fig. 67.

the plaster block *C* (Fig. 69), and after being coated over with oil this is cast up in a manner similar to the first plaster block. When the duplicate core is removed from the plaster, the matrix is obviously that required for the desired core-box. For defining the relative positions of the plaster half boxes, pin dowels are cast into the first-made half and these when cast over for the other half make their own sockets. Another method is to form dips or registers upon the first cast-up block which in turn form their own seatings for defining relative positions.

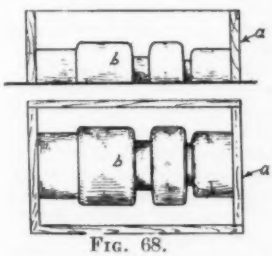


Fig. 68.

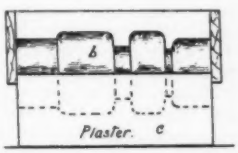


Fig. 69.

Metal core-boxes of this type are very economically produced by means of these plaster boxes, the plaster being cut down to suitable thicknesses around the core-forming portion of the box, so that excessive and unnecessary weight is obviated.

THE IRON AND STEEL INSTITUTE.—The annual meeting will be held by kind permission at the Institution of Civil Engineers, Great George Street, London, S.W., on Thursday and Friday, May 13 and 14, 1915. The date of Thursday, May 13, has been provisionally fixed for the annual dinner, and a further announcement will be made if it is found possible for the dinner to take place. In regard to the autumn meeting, it has been provisionally decided to hold this in London during the week ending September 25, 1915.

Some Scientific Features of Cast-Iron.

Before the Birmingham Branch of the British Foundrymen's Association on January 23, Dr. J. E. Stead, F.R.S., lectured on "Some Scientific Features of Cast-Iron." The meeting was also attended by members of the Staffordshire Iron and Steel Institute, the Birmingham Metallurgical Society, the University Metallurgical Society, and the Staffordshire County Metallurgical and Engineering Institute. Mr. C. Heggie (Branch-President) occupied the chair.

Dr. Stead said his object was to deal conversationally with the subject rather than to deliver a set lecture. Anyone who had done research work or who had studied nature, particularly with regard to the metallurgy of iron and steel, must occasionally have made mistakes in interpretation and consequently have found it necessary to modify early conceptions. Part of his (the speaker's) duty was to show how students had occasionally found it necessary to modify their conclusions as the result of acquired knowledge and different interpretations. It was the work of the research scientist to discover the life history of all classes of cast-iron from their birth when first they began to solidify up to the time when they became quite solid and cold and reached maturity. Contrary to the conclusions of some chemists, all cast-iron, no matter how grey during its passage from the commencement of solidity to the cold condition, invariably commenced white and then gradually changed to grey during cooling. There was overwhelming evidence that white carbide of iron crystallised out as such, and owing to the influence of the silicon present it decomposed into graphite and iron. It was clear that graphite, so far as the strength of cast-iron was concerned, was an enemy of the cast-iron founder. For, as was not generally known, the diminution of 0.1 per cent. of graphite below 3.2 per cent. down to 2 per cent. was coincident with an increase in the transverse strength of approximately 2 cwts. on the standard bar, 36 in. × 2 in. × 1 in., and 0.8 tons per square inch in the tenacity, other constituents being approximately constant.

Each 1 per cent. of graphite in the finished casting was coincident with an expansion of about 1.8 per cent., due to the decomposition of the equivalent carbide which took place during the cooling down. The greyness in cast-irons was the result of decomposition during cooling of a definite chemical compound, carbide of iron, which had a white fracture. The strength of a casting largely depended not only on the amount of graphite it contained but on the form in which that element existed. If it was present as isolated islands, as in a black-heart malleable casting, that was the most favourable form, and such castings could be bent to a considerable angle before breaking. If it existed in flat plates the iron was very fragile. If the graphite present was in a curved, dish-shaped form, the most common form in cast-iron, that was favourable to greater strength than when it was in the form of plates. But if it existed in very large plates, or in larger, semi-spherical forms, the iron was weaker in consequence. Dr. Stead showed a most interesting example of the weakness of native graphite, which was readily split into sheets. In very small, hard castings, which were grey when cold, decomposition nearly always commenced at a multitude of independent centres and proceeded radially from these. In other words, the iron passed through the three stages of youth, middle age, and maturity, or white, mottled, and grey. The formation of graphite and iron from carbide was accompanied by a considerable expansion, for 100 volumes of carbide, if completely decomposed into iron and graphite, expanded to 113 volumes. A pure cast-iron, with about 4 per cent. of carbon in passing from the liquid to the solid state, contained at first all the carbon as carbide, but soon after solidification on slow cooling a portion of the carbide, equivalent to 3.3 per cent. of carbon, decomposed into graphite and pearlite. The expansion due to the decomposition was equal to about 6 per cent. on the whole casting. The crystallisation of the carbide took place in the liquid form before complete solidification. The most fusible combination of iron and carbon was that which solidified at about 1,130 deg. C., and contained about 4.3 of carbon and 95.7 of iron. When it first became solid it contained 50 per cent. of carbide of iron and 50 per cent. of iron containing 2 per cent. of carbon dissolved in it. When completely cold it comprised carbide of iron 59 per cent., pearlite containing 0.9 per cent., carbon, 41 per cent. This eutectic of iron and carbon when solid was characterised by a honeycombed structure. In pure Swedish and other pure irons it was the last portion to become solid. With regard to the whiteness of iron, if a grey iron containing 4.7 per cent. silicon were chilled with sufficient rapidity it would be in a white condition.

Dr. Stead exhibited two specimens of the same iron cast in sand, one of which was allowed to cool slowly while the other was removed from the sand after it had just become solid and was slightly chilled in water. The fracture of the first was grey and the second quite white, a conclusive proof that the iron immediately after the solidification was white, and that decomposition of carbide occurred during normal cooling. The speaker maintained that all the elements in pig-iron were of value if used intelligently. Even sulphur, always regarded in the past as having a satanically evil influence, was really sometimes a beneficent friend to the foundryman. At this point it was shown by the lecturer how the addition of a little iron pyrites containing 50 per cent. of sulphur to a high 4 per cent. silicon iron improved the transverse strength by about 30 per cent.

A good old-fashioned foundry foreman had once said to him (the lecturer), "I can always tell by the taste of a fracture whether iron will be strong or weak if you will allow me to put my tongue on it," and he proved that he could. There was some commonsense in that, which merely meant that by putting his tongue on it he could tell, according to the roughness or smoothness of the fracture, whether it was weak or strong. The explanation undoubtedly was found in the difference in the character of the graphite crystals.

Further slides were exhibited showing some peculiarities in castings. The hard spots so often found were shown to be blowhole cavities which had been filled with the very fusible eutectic forced into them due to expansion during solidification of the iron, and the consequent pressure produced by the decomposition of the carbide. Sometimes the cavities were only partially filled, and the inclusion in globular form could be extracted and examined. They always, when broken, had a white fracture, and were exceedingly hard, and had the honey-

combed structure of the iron-carbon or iron-carbon-phosphorus eutectic.

Continuing, Dr. Stead explained why some very high-class and valuable pig-irons had a white centre and an open grey envelope. It was the result of the outer layers contracting and pressing the interior and hotter portion before decomposition of the carbides was effected, the pressure itself being sufficient to arrest the decomposition. Such white-heart pigs were most suitable for making chilled castings, and although the product of hot-blast furnaces making hematite pig-iron were regarded with prejudice by the British ironfounder, who called that material "rotten" stuff, yet it found a ready market in Germany where there was less prejudice on those subjects. The sales to Germany, of course, took place in peace time, but, generally speaking, those irons were now almost unsaleable. It was quite certain that the same iron, if the cooling on the pig bed had been retarded, would have shown a grey fracture throughout, and no founder would have objected to it. But because of an indication of high quality, which was really the case in iron having that white centre, the founder rejected the material as most inferior.

When phosphorus was present in cast-iron the final point of solidification was about 943 deg. C., or that of a triple alloy or ternary eutectic of iron, carbon and phosphorus in the following proportions:—Carbon, 1.92; phosphorus, 6.89; and iron, 91.19. It was that eutectic that liquated out of the sow ends of phosphoretic pig-irons when broken on the pig beds. When small and rather hard castings of phosphoretic iron solidified, the graphite separating in independent nuclei exerted pressure in the metal, and this squeezed the liquid eutectic to the boundaries of the secondary or mottled formation producing a net-like structure in sections of the cold metal. When phosphoretic iron in a plastic condition was subjected to hydraulic pressure the eutectic was squeezed out of the metal. If a phosphoretic pig-iron was heated to above the melting point of the eutectic, say 980 deg. C., a portion of the eutectic liquated out of the pig. If the metal was very grey when solid the eutectic remaining was distributed throughout the metal and no longer contained carbon, as that element diffused out of the triple eutectic formed at first, leaving a eutectic with about 10 per cent. phosphorus called a binary eutectic.

Exhibiting a series of slides dealing with pearlite, Dr. Stead called attention to the pearly appearance of this constituent which really accounted for its name. Sulphur retarded decomposition of the carbide, and consequently produced fine graphite plates and strong iron. That action was probably due to traces of sulphur crystallising out with the carbide, which caused it to decompose at a lower temperature. Silicon had the reverse effect, due probably to a little of the silicon crystallising out with the carbide—a very unstable alliance, which decomposed at a relatively high temperature; or to the diffusion of a portion of the silicon from the fir-tree crystallites into the carbide. High silicon *per se* greatly strengthened iron, but tended to produce large graphite plates and on that account weak iron. High silicon and high sulphur together produced a fine-grained and stronger iron.

Next were exhibited a series of slides showing the precise effect upon the structure of the various developments and chemical processes described. The fir-tree crystallites from the interior of a steel ingot were exhibited, which in that case were much larger and easier to examine than those in cast-iron. An exceptionally fine photograph, showing the development of the crystals in an ordinary foundry casting, was also shown. Of course, in such a casting 4 per cent. carbon was never reached. The foundryman generally had sense enough to keep the carbon to near 3 per cent. By means of further slides Dr. Stead showed the effect of putting in a little silicon in accelerating the decomposition of the carbide. He called attention especially to the beautiful tracery of the eutectic before it decomposed. It could be seen also how the graphite plates began to grow between the separate masses of the eutectic, and this continued until eventually the whole mass changed from white to graphitic iron. The explanation of that appeared to be that at the borders a little extra silicon had found its way, and silicon being the arch-enemy of the carbide, decomposition commenced. Silicon might be described as very aggressive, and, in fact, always found a "place in the sun."

Various slides were exhibited showing how the carbon in very grey pig diffused out of the triple or ternary eutectic, and, passing this, and after diffusing through the matrix eventually was precipitated as graphite. Special attention was called to a cold-blast Staffordshire iron used for making chilled rolls and similar castings. It only contained 2.2 per cent. of carbon, with practically no phosphorus. Attention was called to the primary crystallites of the fir-tree type, which formed before the eutectic in cast-iron, containing under 4 per cent. of carbon. In the final stage below 943 deg. C. there was, so to speak, a quarrel between the phosphorus and the carbon, which invariably resulted in the expulsion of the latter, although these two elements were very friendly together when the metal was at a high temperature. Attention was called to the same features in samples of Staffordshire and other irons. A ready method of determining roughly the amount of phosphorus present in grey iron was to polish it, and then apply nitric acid, which had the power of etching very strongly and darkening all except the phosphorus eutectic, which remained brilliantly white. By examining it under the microscope one could judge from the relative mass of those white particles how much phosphorus the metal contained. In some irons those tiny white spots stood out conspicuously like stars in the firmament.

The concluding section of the lecture was devoted to a striking and beautiful series of colour-photographs showing the complicated structure of the eutectics and the constituents of the pig-iron. Referring to a suggestion that the binary eutectic of iron and phosphorus should be called Steadite, Dr. Stead said he strongly advised the adoption of the proper name, because "Steadite" failed to convey an idea of its character.

The speaker strongly urged foundrymen not to be content to do things just because their grandfathers did. By judicious mixing and the use of brains they could save themselves a lot of money in the purchase of material by using less expensive iron.

Discussion.

Mr. F. Johnson said the lecturer had stated that they could safely have phosphorus and sulphur in cast iron, but a little too much of each was very bad, and yet not nearly so bad as graphite. The same principle was applicable to non-ferrous metals, of which a good example was copper. They might have elements which were considered beneficial up to a certain point, such as arsenic and nickel, but if they got an excess of each the result was very bad for the copper. But they rarely considered

oxide of copper, which, if increased to the same extent, was far more detrimental, although circumstances rendered its presence, like graphite in cast iron, at once imperative and unavoidable. With regard to one of the photographs shown of a malleable casting, he understood that that contained 0.4 per cent. of sulphur. He would like to know whether the sulphur was there in the form of iron sulphide or as manganese sulphide.

Dr. Stead said that there was a very little manganese, amounting to 0.2, and it would be mainly sulphide of iron.

Mr. Johnson, continuing, said that another question on which he would like information was as to the way in which the carbide decomposed. Was the carbide directly decomposed into iron and carbon, or did it first of all pass into solution and become austenite. That point had been raised by other metallurgists. Dr. Stead showed that they had the austenite surrounded by the eutectic, and that decomposition tended to take place at the edges of the eutectic crystals; and he appeared to attribute that to an assumed excess of silicon at the edges of those crystals. But it would be also an explanation to say that the carbide of iron went into solution as primary austenite, and that as the primary austenite threw out the carbon the austenite of the eutectic was enabled to reinforce the primary austenite with carbon by diffusion.

Another point he would like to call attention to was suggested by a Paper given before the Institute of Metals some years ago by Messrs. Hudson and Law, who described what they called the triple eutectic in phosphor bronze. That eutectic on solidification was a binary eutectic of copper phosphide and a solid solution. There were three constituents ultimately, but immediately after solidification there were only two. That was not a ternary eutectic. Dr. Stead had described to them a phosphide-carbide-austenite eutectic which he called both triple and ternary. He did not know whether this system of carbide-phosphide had ever been worked out, and if so, whether it contained a eutectic. In such a case Dr. Stead's choice of the term ternary would not clash with the theory of the physical chemists. This ternary eutectic might receive a name conveying that it was a eutectic containing three main constituents, one of which was a eutectoid. He would suggest, for what it was worth, that they should call it a eutectoidal ternary eutectic.

Mr. Walter Macfarlane, F.I.C., recalled the case of a man who claimed to judge the quality of the iron by the smell, and also a practical manager in the North who professed to be able to tell the percentage of iron in an ore by crunching some of it and tasting it. The taster was frank enough to admit that the perfect method was that of chemical analysis.

Mr. W. Mayer (Dumbarton) assured Dr. Stead that he had listened to the lecture with the greatest interest, and they would agree also that the lecturer was really the foundrymen's friend. It had been really an educational lecture, but after all it was all very well to talk to them there; what they wanted was to get Dr. Stead into that nice frame of mind in which he would consent to deliver his lecture to the ironmakers, the men who made the iron that the foundrymen had to use. (Laughter and applause). Reference had been made to Scotch iron, and he could assure the lecturer that while there was good Scotch iron there was also some that was bad, and the fact that he found it necessary to buy his iron by analysis spoke for itself. When they started to talk to the Scotch ironmasters about 1¼ to 1½ per cent. of silicon and ½ per cent. of phosphorus they did not like it. Yet it was the only way to get good castings. If they could by any means commandeer Dr. Stead and enlist his services as a missionary in Scotland, he might be able to do for them what the Scotch ironmakers could not do for themselves. They had to take the product from the furnaces and try to make it into a good casting, and if there was anything the matter with the castings it was always the foundryman who got the blame. However, great progress had been made in metallurgy, and happily similar progress also had been made in the foundry. Really the foundryman had been the pioneer in everything that had been brought about for the engineer. Many a time the foundryman made castings for the engineer when the latter did not really know what he wanted himself. Those things had been too long kept hidden, and all because they had had so many men amongst them who were unable to put their practical thoughts into clear utterance.

Mr. Isaac E. Lester asked Dr. Stead regarding certain transverse and tensile tests quoted, whether the iron used was hematite or not. Another point that had struck him for years past was that the subject of "process" and its place as the great controlling factor in the production of an article, whether as pig-iron or as steel, had not been adequately dealt with. He had tried on various occasions to induce some of his metallurgical friends to give them a Paper on the origin of process and its effect on products. Personally, he had seen some very peculiar cast iron made in very small quantities in the back jungles of India. Yet they got a beautiful cast iron and a most beautiful structure made merely by reducing iron ore with charcoal at an exceedingly low temperature, and then raising to the point of fusion. With regard to cold-blast iron, Dr. Stead seemed to imply that this was not quite so good as Staffordshire men made it out to be, and that hot-blast iron was as much to be desired as cold-blast. Well, that was rather hitting Staffordshire, because goods made from Staffordshire cold-blast iron had a reputation all over the world, and they really relied for their trade on the good name and superior qualities of that product. He could not help thinking there was something inherent to the process which affected the composition and structure of iron which gave it the quality and the balance so necessary in the making of high-class castings. Judging by fracture and by analysis both were very important. But a man could not always stop to go through an analysis, and unfortunately there was no method by which a man could tap his furnace and tell before a casting was made with sufficient accuracy the character of the metal he was about to use. If Dr. Stead could give them some hints by which a rapid conclusion like that could be arrived at the ironfounder would be greatly indebted to him.

Mr. F. C. A. H. Lantsberry remarked that he had often wondered how it was that in steel containing 99 per cent. of iron and about ½ per cent. of manganese, the whole of the sulphur should be combined in the manganese and not with the iron. They would have expected that the bulk of the sulphur would combine with the iron in accordance with the chemical law of mass action. Dr. Stead showed them that the very fact that the manganese sulphide was insoluble in liquid iron was an explanation why in steel the whole of the sulphur was combined with the manganese, because in a chemical system it was always the insoluble material which was formed.

Mr. F. J. Cook said that one of the outstanding features of the lecture was the definite manner in

which Dr. Stead spoke of the various elements. They frequently had illustrations given them of elements spoken of in a general way. But Dr. Stead had brought some of them down to a definite engineering proportion. For instance, he had definitely showed the effect of 0.1 per cent. of graphite on the strength of the casting. That was what was wanted—definite percentages giving exact results. The lecturer had emphasised the great importance of the quantity of carbon present, and that was not generally regarded according to its real importance. Some people spoke glibly of the percentage of combined carbon, and did not take any notice of the total carbon, but Dr. Stead had shown that total carbon had great influence. In connection with the network structure which had been squeezed between the junction of the binary crystals, that had generally been recognised as being associated with very strong irons. He would like to know whether the lecturer knew of its being otherwise regarded. He had also pointed out the practical meaning and influence of sulphur. As a rule, their grandfathers considered sulphur the greatest evil that a man could possibly meet with. Personally, he (Mr. Cook) had been considered as having sulphur on the brain, but had always contended that sulphur if judiciously used was one of the greatest blessings a foundryman could have. A lot of things had been said with regard to the detrimental effect of sulphur, but some of its good effects had been pointed out by Dr. Stead, and with those views he agreed, but it should be added that such sulphur must always be associated with high casting temperature if satisfactory results were to be obtained.

Mr. R. Buchanan said it had been observed by himself and others that irons which contained large percentages of total carbon, such as No. 1 iron, when made into castings shrunk very considerably, so that there was considerable liquid contraction or "draw-holes." Some years ago, when he was connected more intimately than at present with metallurgy, he and his colleagues had an idea that the cause of the sinking might be obviated by the use of scrap. If there was a large amount of graphite and therefore a large expansion, they would have expected that that would hinder the formation of shrinkage holes, but in practice they found that it was not so. He would like Dr. Stead's views as to why the large expansion which took place when using No. 1 iron did not eliminate the draw-holes or the liquid contraction holes with which they were too familiar.

Dr. Stead, replying to the discussion, said he would only deal very briefly with the points raised. In regard to one of them, it was quite true that they must have austenite before they could have graphite. With regard to the ternary eutectic, the one he had referred to had all the properties of a eutectic in that it had a definite and single melting point. When giving a Paper before the Cleveland engineers on the science of the foundry, he had said that when the foundry people began to think that the chemist was as useful to them as the timekeeper, there was some hope for them. (Laughter.) Really the chemist was more valuable than the timekeeper. It had been suggested that he should talk to the pig-iron manufacturers, but however much they were talked to, those gentlemen were liable to the same kind of variability as the foundrymen, and even if the manufacturers analysed all their materials to meet every requirement in regard to the percentage of silicon and so on, the foundryman would still have to take the irons and mix them together with brains, and they must have a chemist to do that. It was quite a mistake to suggest that he made any reflection on cold-blast iron. The only thing he said was that occasionally they got a cold-blast quality from a hot-blast furnace, and in that case being cheaper it was worth having as a substitute for cold-blast iron. Imitation was the highest form of flattery, and when he told an ironfounder that he could make an iron to imitate Scotch iron without going to Scotland for it, surely that was a compliment to Scotland. In answer to a question as to the condition of the sulphur in a malleable casting shown in the slides, Dr. Stead said the sulphur was in excess and the globular masses must, of course, be a mixture of manganese-sulphide and iron sulphide. They could not distinguish one from another, except by the colour. The colour of the iron sulphide was yellow, and the sulphide of manganese was of a dove colour. He felt that he was under an obligation to them because he had had such an intelligent audience, without which no man could be a good talker.

The proceedings concluded with a hearty vote of thanks accorded by acclamation to Dr. Stead.

PROTECTION OF IRON FROM CORROSION.—"Ferro-zincing" or "Ironizing" as a means of protecting iron and steel from corrosion has many applications, one of the chief, at the present time, being for coating tubes to prevent pitting and corrosion. The use of zinc as a protective coating is due to the fact that zinc is electro-positive to iron and steel, and in the presence of moisture a galvanic couple is set up and the zinc being electro-positive to the iron corrodes first and as long as any zinc is left in contact with the iron the iron is protected. Mr. Cowper-Coles, the inventor of the process known as "Ferro-zincing," has found by experiment that pure electrolytic iron forms a very effective protective coating; chemically pure iron being practically rustless; thus if sheets of electrolytic iron and ordinary rolled iron be freed from scale and oxide and placed in a very dilute solution of sulphuric acid and connected to a millivoltmeter, it will be found that the current flows in such a direction as shows that electrolytic iron is electro-positive to ordinary rolled iron. The only impurity of any importance in electrolytic iron is hydrogen, which appears to be partly alloyed with the iron, but this is found to render the iron more electro-positive, for if a piece of electrolytic iron be annealed (whereby the hydrogen is expelled) and then tested against a piece of unannealed electrolytic iron by the above test, it will be found the unannealed sample is electro-positive to the annealed sample. It will thus be seen that a coating of electrolytic iron forms an admirable protective coating, and if afterwards coated with zinc the result is still better.

THE SCHNEIDER-CREUSOT WORKS.—These famous works in France, which have been brought into more than usual prominence by the war, are situated in the district of Saone et Loire, to the west of the town of Chalons-sûr-Saone, which has a population of 40,000 inhabitants. The works had their beginning towards the end of the 18th century in a small ironfoundry, which was reconstructed and extended in 1835 by Eugen Schneider, who was a native of Lorraine. Apart from the main works at Le Creusot, the present firm of Schneider & Company are owners of a shipbuilding yard and arsenal at Chalons-sûr-Saone, also of coal mines at Decize and Montchanin, and of iron mines in Spain as well as in Lorraine. They have also a turbo-dynamo works in Champagne, artillery workshops and practice grounds at Le Havre, Harfleur and Toulon, and finally a manufactory for fireproof products at Perreuil. The situation of the main works is not exactly ideal, because the coal mines in the neighbourhood can supply only about 25 per cent. of the quantity required, and the supplies of iron ore must be drawn either from Lorraine or from abroad.

Machinery for the Treatment and Mixing of Sands and Moulding Materials.

By Algernon Lewin Curtis, M.E.

(*Continued from page* 80.)

A very simple method of determining the porous or venting qualities of a sample of either raw or mixed sand is to pass a current of oxygen through a standard test piece of the material which has been thoroughly mixed with sufficient water to ensure its maximum cohesive property, and rammed or compressed at a given pressure. To carry out the experiment a cylindrical vessel, as shown in Fig. 4, having a volume of approximately 1 cub. in., is used as a mould for the core or test piece. The screw cap which fits on top of the mould has a small hole

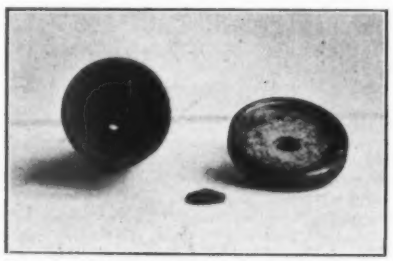


FIG. 4.—MOULD FOR TESTING POROUS OR VENTING PROPERTIES OF SANDS, SHOWING SCREW CAP AND WIRE GAUZE.

in its centre to allow the escape of oxygen. The bottom of the mould, which tapers down into a narrow neck forming a suitable connection for stout rubber tubing, is also bored out to admit oxygen at the bottom of the test-piece or core. A small piece of 60-mesh wire gauze is inserted inside the mould to prevent sand entering the nozzle when being rammed or compressed. Stout rubber tubing is

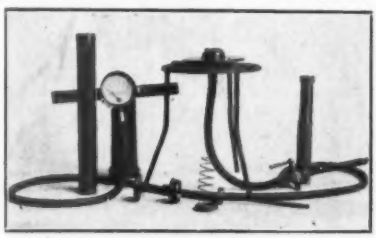


FIG. 5.—MOULD IN POSITION ON TRIPOD FOR FILLING WITH SAND.

wired on to the connection at the bottom of the mould and connected to a three-way cock, which latter is again connected by rubber tubing to an oxygen cylinder and independent pressure gauge.

The mould is then inserted in a flanged support, the latter being placed on a tripod as shown in Fig. 5. A given weight, say, 22 grammes, of the sand to be tested (which has been previously mixed with its correct moisture content) is then taken, and one-third of this amount is placed in the mould direct, care being taken that the small piece of wire gauze exactly covers the whole at the bottom of the mould. The cylinder of a Curtis mould-testing instrument* with plunger spring and piston stem removed, shown in Fig. 5, is placed exactly over the mould on the tripod, and the remaining two-thirds of the sample dropped into the mould by pouring it through the top of the cylinder. The plunger spring and piston stem, shown in Fig. 5, are now inserted in the cylinder of the mould-testing instrument and the sand rammed or compressed by pressing on the handle at the end of the piston stem until a pressure of 20 lbs. per sq. in. is registered. Fig. 6 shows the

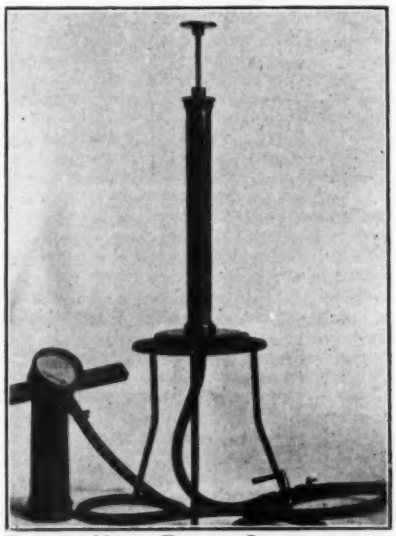


FIG. 6.—MOULD-TESTING INSTRUMENT IN POSITION ON MOULD AFTER RAMMING SAMPLE.

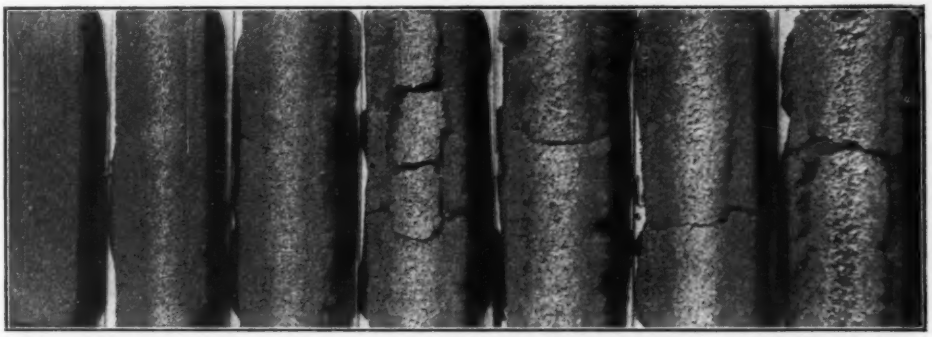
instrument in position after ramming a sample of sand. A ramming pressure of 20 lbs. has been found to be a good practical standard, though any desired pressure up to 56 lbs. per sq. in. can be obtained on the instrument. The latter is now withdrawn from the mould and the cap, lined with suitable packing, screwed tightly on.

For very strong sands, plastic clays or soils, a 40 lbs. per sq. in. pressure gauge is necessary, as such materials often require a pressure of nearly 40 lbs. of oxygen to penetrate the face of the test-piece. With weak green-sand, core or dry-sand mixtures, however, a pressure gauge calibrated to 10 lbs. per sq. in. is more convenient, besides being more accurate.

Oxygen is now turned on, so that the pressure lies between the oxygen cylinder, the three-way cock, and

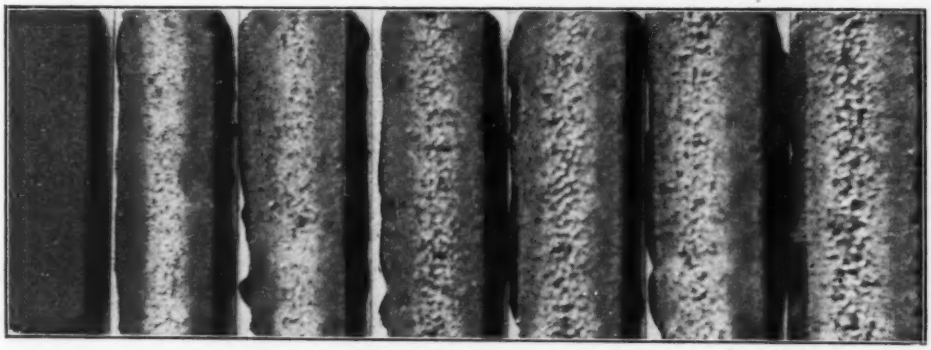
* See "Foundry Trade Journal," August, 1913.

the pressure gauge, but not on the test-piece in the mould. Commencing with a pressure of 1 lb. per sq. in., oxygen is instantaneously applied to the test-piece in the mould. The above operation is continued in units of 1 lb. pressure, until a small piece of the face of the test-piece or core is blown out through the hole in the centre of the screw cap on the mould. The pressure at which this rupture occurs, however, is not the porous factor of the sand, because the test-piece at this pressure offered a resistance to the opposing force of oxygen by having part of its face blown away. The actual porous factor or venting capacity of the sand is therefore that pressure of oxygen which the test-piece withstood previous to having its face ruptured.



Normal 1,200 1,300 1,400 1,500 1,600 1,700 Deg. C.

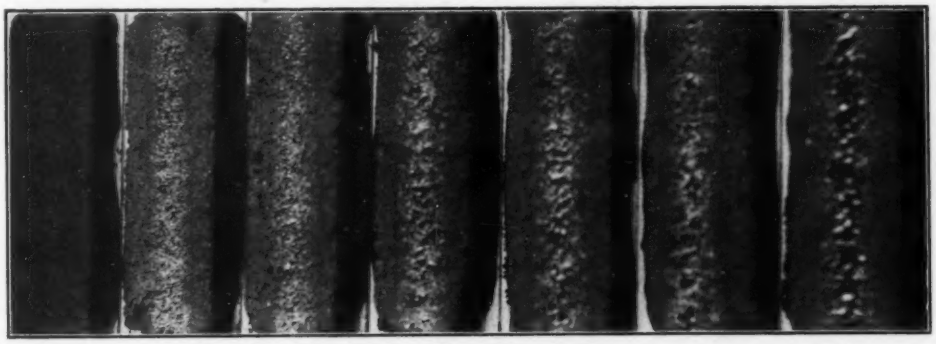
FIG. 10.—OLD SAND TEST PIECES, ¾ FULL SIZE.



Normal 1,200 1,300 1,400 1,500 1,600 1,700 Deg. C.

FIG. 11.—FACING-SAND MIXTURE TEST PIECES, ¾ FULL SIZE.

Fig. 7 shows a test-piece of raw sand with a clean face after being subjected to a pressure of oxygen of 20 lbs. per sq. in. This sand was mixed with 5.20 c.c. per cent. water and rammed at a pressure of 20 lbs. per sq. in. Fig. 8



No mal 1,200 1,300 1,400 1,500 1,600 1,700 Deg. C.

FIG. 12.—NEW RED SAND TEST PIECES, ¾ FULL SIZE.

is a test piece of an inferior facing-sand mixture showing a rupture on its face which occurred when subjected to an oxygen pressure of only 6 lbs. This latter mixture was mixed with 7 c.c. per cent. moisture and also rammed at a pressure of 20 lbs.

The object of the above test is to prove physically the ability of a sand or moulding material when rammed in a moist condition to vent a large pressure of gas applied instantaneously. To better illustrate the value of the above a practical example may

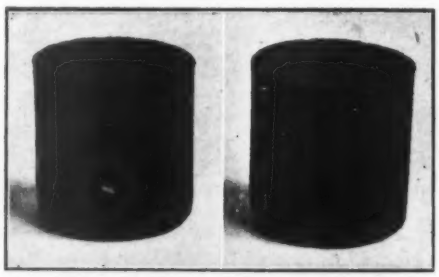


FIG. 7.—TEST-PIECE OF SUPERIOR RAW SAND SHOWING CLEAN FACE AFTER EXPOSURE TO 20 LBS. SQ. IN. OXYGEN PRESSURE.

FIG. 8. — TEST-PIECE OF INFERIOR WEAK, DENSE FACING MIXTURE, SHOWING RUPTURED FACE UNDER PRESSURE OF 6 LBS. SQ. IN. OXYGEN PRESSURE.

be given. The following sand mixture was extensively used for making grey-iron castings in green-sand moulds:—

343 *Parts by Weight New Red Moulding Sand.*

Size.	Per cent.
Retained on 50 sieve	7.700
Retained on 100 sieve	54.390
Sieved through a 100 sieve	37.910

294 *Parts by Weight Old Sand.*

Size.	Per cent.
Retained on 50 sieve	20.520
Retained on 100 sieve	40.520
Sieved through a 100 sieve	38.960

FIG. 9.—CASTING MADE FROM AN INFERIOR FACING-SAND MIXTURE WITH A POROUS FACTOR OF ONLY 6 LBS. (¼ FULL SIZE).

To the foregoing was added 16 per cent. by weight of coal dust. The size of the resultant facing sand mixture was :—

Size.	Per cent.
Retained on 50 sieve	20.570
Retained on 100 sieve	51.720
Sieved through a 100 sieve	27.710

The final mixture was therefore somewhat larger than either the new or old sands, due to the addition of 16 per cent. coal dust, which was of large grain, though its surface factor was not taken.

When mixed with 7 c.c. per cent. water and rammed at a pressure of 20 lbs., the face of a test piece made from the above facing-sand mixture was ruptured when exposed to a pressure of 6 lbs. per sq. in. oxygen. The new red moulding sand proved very dense and weak, venting at 7 lbs. oxygen pressure when mixed with 5 c.c. water and rammed at 20 lbs. per sq. in. The old sand when mixed with 5.75 c.c. water vented at 5 lbs. oxygen when rammed at a pressure of 20 lbs.

A perusal of the above figures will suffice to show that owing to low porous quality and weak nature the new red sand was unsuitable to mix with two materials (*i.e.*, old sand and coal dust) weaker than itself; consequently the mixed product was so weak and dense that a pressure of 6 lbs. of oxygen blew away part of its face.

In checking the above results reference should be made to Fig. 9, which shows a photograph of part of a finished casting made from the above mixture. It will be noticed that this casting is badly cut and scabbed, due to the inferiority of the facing sand used.

Because a facing-sand mixture contains a large percentage of coal dust, it must not be assumed that cutting and scabbing will be eliminated. In fact, 16 per cent. of coal dust in a weak, dense facing mixture like the above was one of the causes of the trouble; the chief of which lay in the use of bad new and old sands. An examination of the refractory qualities of the three sands contained in the mixture showed the new red sand to possess relatively poor refractory qualities, while the facing-sand mixture and old sand had low fusing points.

Figs. 10, 11 and 12 show the test pieces of the refractory qualities of the three different materials, after exposure to heats of 1,200 deg., 1,300 deg., 1,400 deg., 1,500 deg., 1,600 deg. and 1,700 deg. C.

SOUND STEEL INGOTS AND CASTINGS.—A process for making sound steel ingots or castings has been patented (U.S. 1,116,899—November 10, 1914) by Mr. L. B. Lindemuth, of Steelton, Pennsylvania. It consists in placing on top of the ingot or casting, after it has been poured, a combustible in the form of a metalloid which has a high heat of combustion and which, when oxidised by an oxidising blast, will not enter into the steel nor change its composition. The substances recommended are silicon as ferro-silicon (50 per cent.), titanium as ferro-titanium, or aluminium, any one of which is prone to form slag rather than to combine with the metal or dissolve in it, except to a very limited extent. It is claimed that under the most unfavourable conditions these substances will enter only about an inch into the surface of the metal that is agitated by the blast. Each has a specific gravity less than that of the molten iron. The heat of combustion maintains the top of the casting molten until after the body has set sufficiently to overcome any tendency to form a pipe. The inventor states that 50-per cent. ferro-silicon has been used with uniform success on a large number of ingots and castings. The ferro-silicon is added from time to time in small lumps to the surface of the metal, which is agitated by an air blast from a ½-in. pipe. About 5 lbs. of ferro-silicon per ton of ingots is required.

Electric Furnace for Medium Temperatures.*

By Ernst M. Schmelz.

The furnace here dealt with is an evolution of the well-known Stassano steel furnace, being built on the same principle, but adding such particular features as the lower melting temperature of the charge requires. About ten years ago Major Stassano, an officer in the Italian Army, designed an electric furnace for the treatment of copper ore. On account of the great amount of slag to be handled in a process of this kind, the furnace had a double chamber with the floors on different levels and two separate tapping holes for the charge and the slag. In all other particulars it was identical in design with the Stassano steel furnace which has so frequently been described.

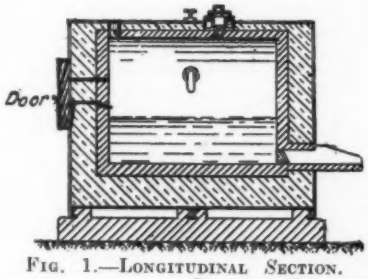


FIG. 1.—LONGITUDINAL SECTION.

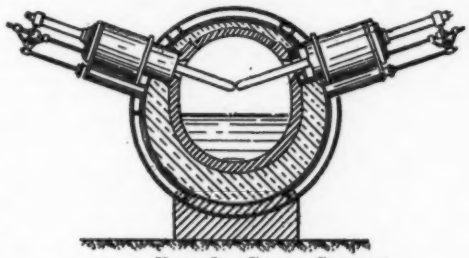


FIG. 2.—CROSS SECTION.

STASSANO FURNACE FOR MEDIUM TEMPERATURES.

The new furnace is intended for the melting of metals only, and therefore, it was possible to do away with the inconvenient double chamber and work out a simple design with the special point of high thermal efficiency in view.

Figs. 1 and 2 show a longitudinal and a cross-sectional view of the furnace, and give a clear idea of its general design. The melting chamber is lined with magnesite, this being the highest refractory material obtainable, and has an oval section consisting of a semi-circular bottom and top, and two straight side walls. There is also an outer lining of fire brick, and the whole furnace is enclosed in a steel shell, and is either stationary on its base, or suspended on two trunnions, in case it is desirable to use a tilting arrangement instead of the tapping hole.

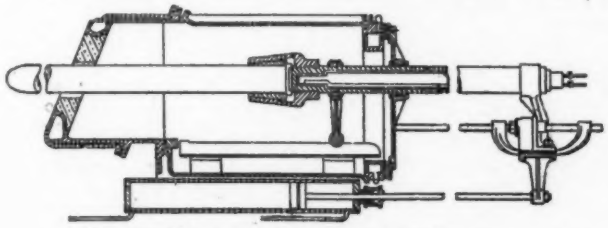


FIG. 3.—ELECTRODE HOLDER OF FURNACE.

The heating medium employed is the pure electric arc created between the points of two or more electrodes, which enter the furnace from the side. At the points of entry there are water-cooled jackets for the protection of the electrode holders, the details of which are shown in Fig. 3. These electrode holders have to be protected from excessive heat, and therefore are built hollow and contain an inner tube electrically insulated from the other parts of the electrode holder, which tube is connected with a water-cooling system. The regulation of the electrode is effected by small hydraulic cylinders placed underneath the water jackets. They are double-acting and governed by four-way cocks mounted on a little standard beside the furnace. It is evident that if water under pressure is admitted behind the piston of the hydraulic cylinder, this piston and the piston rod will move out and thereby force the electrode holder, with which it is rigidly connected, to move in the same direction and increase the space between the electrode points. This causes a decrease in the amount of amperage entering the furnace at a given constant voltage, and correspondingly decreases the heat in the furnace. The reverse movement of the piston will, of course, have the contrary effect, and by this simple and quick-acting system a perfect and smooth regulation of the furnace operations is assured, doing away with all complicated electric starting and regulating apparatus as used in other furnaces.

To protect the charge from an excessive heat the electric arc is placed approximately in the centre of the open space between the surface of the bath and the roof, and the second or outer lining is much thinner where it covers the roof than on the bottom part of the furnace, owing to the eccentric location of the melting chamber in regard to the outer shell.

The raw material is brought into the furnace through one or more charging doors in the sides which can be tightly closed, which arrangement in combination with the air-tight construction of the electrode holders and stuffing boxes admitting the electrodes, affords a completely neutral atmosphere during the whole time of operation.

In regard to the practical use of this furnace, it has several obvious advantages over any ordinary melting furnace using oil or gas as fuel. The use of electricity, the only absolutely pure heating medium,

*Abstract of Paper presented at the annual meeting of the American Institute of Metals, 1914.

prevents the introduction of any impurities like sulphur, etc., from the fuel into the charge and the hermetically closed melting chamber affords a complete control over the total process from a metallurgical point of view. Both these features unite in keeping the heat efficiency far above the one obtainable in an open-draft furnace. An experimental furnace 120 kw. melted 1,000 lbs. of red copper in less than two hours, using 240 k.w.h. per ton of metal, or, 0.12 k.w.h. per pound. A larger type will, of course, show a tendency to decrease the melting time as well as the amount of electric energy used per ton of molten metal.

The furnace can be designed for the use of direct or alternating current, either single- or three-phase, and with a voltage of 75 to 220 volts, according to the size of the furnace. The number of cycles is immaterial. The power factor is very high, cos. being 90 per cent. and higher. The regulation is very simple, and requires no electrical apparatus, but only a hydraulic arrangement, working on about 50 lbs. pressure. No special transformers or starters are required. The upkeep of the furnace is very economical, the repairs of the lining can easily be done at night or over Sunday.

Electric Melting of Brass.

This subject was dealt with in a Paper read recently before the American Foundrymen's Association by Mr. G. H. Clamer and Dr. Carl Hering. The general advantages of electric furnaces for brass melting were first discussed, and it was pointed out that the ideal method would be to melt and pour as quickly as possible, hence in as small lots as the particular conditions of the foundry required. It was suggested, however, that for small castings at least a high-power tilting brass furnace of this type could be constructed small enough to be transported to the moulds, pouring directly into them. A description of the general construction of the Hering pinch-effect furnace was then given, and it was pointed out what a large amount of heat is carried out of the resisters or heating holes in the furnace bottom effectively by the rapidly flowing metal—exceeding that of a row of electric arcs in those holes. At present about 25 to 50 kw. are converted into heat in each hole (or roughly about 90,000 to 200,000 B.T.U. per hour), with the probabilities that this can be considerably increased. The authors continued :—The correct proportioning of these holes and the current are of great importance. For brass these proportions are quite different from those for steel. The furnace must be specially designed for each metal, though variations in the compositions of brasses and bronzes can be accommodated in the same furnace by regulation of the electric current. Even copper, with its very low resistance, can be melted commercially in these furnaces without requiring impractical proportions. The higher the electrical resistivity of a metal the better the proportions become.

The power factor of the furnace, even with 60 cycles, is not low, being in the eighties and nineties, and even this small reduction from 100 per cent. is no doubt largely, if not all, in the transformers and could be avoided in a better design of the transformers.

The Hering furnace has so far been used for melting very light brass and bronze chips, which gave trouble in the fuel furnaces. Many tons of these light curly and oily brass chips, with much mechanically mixed iron, were melted and cast in the form of clean ingots, nearly 8 lbs. per kw.-hour delivered to the furnace transformers, equal to about 12.5 kw.-hours per 100 lbs. poured. But there were various losses which can be avoided in future. Short runs, with clean ingot charges, indicated that, even with the easily avoidable excesses in the losses, 10 lbs. per kw.-hour could be obtained in this furnace; hence, in better designs, even still better efficiencies than this can, reasonably be expected. But this figure depends largely on the amount of superheat required by the particular foundryman.

Comparative costs with fuel furnaces can be only crude, because the data concerning them differ so greatly in different foundries. But taking what appear to be fair general averages, the following rough comparisons can be made, limiting this comparison to only the fuel or current, the crucibles and the loss of metal per 100 lbs., assuming 16s. 8d. per ton for the coke, and the average value of the metal as 5d. per pound.

Pit, natural-draft, coke furnace:—Coke, 45 lbs., 4d.; metal loss, 2.5 lbs., 12.5d.; crucibles, 3.5d.; total, 20d.

Pit, forced-draft, coke furnaces: Coke, 35 lbs., 3.15d.; metal loss, 2.5 lbs., 12.5d.; crucibles, 3.5d.; total, 19.15d.

Tilting, forced-draft, coke furnaces:—Coke, 20 lbs., 1.8d.; metal loss, 2.5 lbs., 12.5d.; crucibles, 3d.; total, 17.3d.

Open-flame, tilting oil furnaces:—Oil, 3 gallons 6d.; metal loss, 3 lbs., 15d.; relining, 0.6d.; total (to which should be added the cost of the compressed-air blast), 21.6d.

Electric furnace:—Power at ½d. per kw.-hr. and 10 lbs. per kw.-hr., 5d.; metal loss, ½lb., 2.5d.; relining, 0.6d.; total, 8.1d.

Electric furnace:—Power at 0.75d. per kw.-hr. and 8 lbs. per kw.-hr., 9.4d.; metal loss, ½ lb., 2.5d.; relining, 0.6d.; total, 12.5d.

The labour cost for charging, pouring, and attending to the operation of the furnace may be the same, but the costs of starting the fires and for handling the coal and ashes are absent in the oil and electric furnaces, and should therefore be added to costs for the coke furnaces. In the wrought-brass industry there is a saving of labour with the electric furnace due to larger ingots, which would no doubt be a much greater item than the difference in cost of melting.

In the above data, taking as an average 19d. per 100 lbs. for coke furnaces and 10d. for the electric, the saving in a plant melting 20 tons per day would be nearly £4,500 per year of 300 days; or for oil furnaces at 21.6d. and electric at 10d., the saving would be nearly £5,700 per year. In estimating the cost of melting it is important to consider not only the price per kilowatt-hour of the electric energy and the other items mentioned above, but also the cleanliness of the "boiled" metal, the avoidance of oxidation or of the formation of sulphides, the possible uniformity of temperature, the production of any desired superheat, the possibility of casting directly into the moulds with the consequent saving of labour, the comfort of the workmen, the economy of floor space, the increase of output by running day and night, the absence of handling of coke, ashes, oil, compressed air, etc., the saving of time in starting fires, etc., all of which have a money value which may in some cases be even a larger factor than the mere cost of the power alone. On the other side of the account is the cost of the furnace, the cooling water, its attendance (one man who could easily attend to several furnaces), and the re-lining; under normal running conditions there is nothing about the furnace which is consumed or wears out except the lining; the electrodes are not consumed.

Pipe Castings.

Before the Halifax Branch of the British Foundrymen's Association, on Saturday, January 20, Mr. A. Midgley, of Halifax, lectured on the subject of pipe castings. Mr. Hurst, of Bradford, took the chair.

Mr. Midgley said he proposed to deal with various kinds of pipes, and the methods adopted for the preparing the pipe patterns.

Straight Pipes.—For a few years they had in use at the foundry at which he was engaged a range of wood models varying from 4 in. diameter to 24 in. diameter. The patterns up to 9 in. diameter were made in two solid halves jointed and dowelled. The flanges were made to fit the diameter of the prints, this being better than recessing them into the print when the pipes were subject to constant alteration. The prints were 6 in. long and in those sizes of pipes which were most in use, several lengths were made, 9 ft., 6 ft., 3 ft., 2 ft., 12 in., and 6 in. Thus it was possible to avoid extra long boxes for short pipes and also possible to make a great many pipes of the same diameter but varying in length, on the same day. Above 9 in. diameter, the pipe patterns were lagged up on bearers or circular blocks, these blocks in most cases being gussetted on one side in preference to crossing the grain at right angles, which he believed was the usual practice. By this method the diameter of the pattern remained more correct and for a longer period than by crossing the grain. Care should be taken to have the gussets at least as thick as the timber used for the bearers. These patterns served their purpose for a number of years, but as the number of pipes required increased, it was decided to lay down a range of iron models from 4 in. to 9 in. diameter inclusive, with suitable boxes, and these proved a decided advantage.

The iron models were made in 9-ft. lengths with due allowance for contraction and machining. They were turned up to correct diameters all over, flanges included. The flanges were recessed into the pipe at each end ¼ in. below the diameter of the print, this ensuring that they sat perfectly true on the pipe without being fastened. The prints were respectively 9 in. and 12 in. long, the longest coming well out of the end of the box and having 1½-in. diameter hole drilled through, this hole enabling the moulder to insert a bar and give the pipe a slight turn before removing the top part, thus breaking any adhesion that might exist between the pattern and the sand and giving a perfectly clean and satisfactory mould. Where square or rectangular flanges had to be used they were provided with a centre dowel and suitable hole in the recess of the pipe to insure that each flange would be square with the other, also all flanges were provided with a fillet, as the absence of these would sometimes cause the flange to draw away from the body of the pipe. Fillets should never be made so big as to interfere with bolt heads.

Standard Tee Pieces and Bends.—These were used in great variety. They were all wood models with half core-boxes, and it had been found that very seldom was more than half needed, especially when the bend or tee piece was set equal either way. These were made in the usual way, and scarcely required describing.

Special Pipes of Various Shapes.—Great numbers of these pipes were made, spring bends, S-shaped bends, Y-shaped bends and almost every shape of pipe known in the trade. A series of large pipes including taper pipes and bends tapering from 39 in. to 36 in., some with flanges at both ends and some with one flange and bell-shaped at the other end had just been finished at the speaker's foundry. In handling these pipes the same method was followed as adopted with template pipes. Formerly when a template-pipe order was received from the drawing office, although all the information possible was given, there was much left in doubt. A template pipe was a pipe which had to fit between two existing pipes and if the angles of the flanges were not correct, when being put into its final position on the job a great amount of work was caused. On receiving the template the practice formerly was to try and place it in a position on a level board approximating to the position it would finally occupy. When put into its place on the job for which it was intended this was not always easy, as sometimes very difficult angles had to be obtained. Although generally successful in this part, it was still necessary to transfer those angles and measurements to the loam pattern, a proceeding which was found to be decidedly awkward. A loam pattern was not the best material on which to fasten flanges that needed to be accurate, and although a great amount of thought and ingenuity was devoted to the matter only an indifferent success was attained, for however accurately the flanges might be placed on the loam pattern there was always the danger of these being disturbed before they were finally rammed up in the mould.

The present method of dealing with template pipes was :—The total length of the template was measured to decide the amount of contraction required, and any special features were noted. Next half circular pieces were prepared to fix on each flange, these pieces being made thick enough to provide for contraction and a definite amount of machining in the total length of the pipe. To these were affixed half circular prints made to the size of the box of the pipe. In fixing these to the template care had to be taken to see that they were parallel on the joint, as by so doing a perfectly true joint was ensured. The next procedure was to make a core-plate to follow the contour of the pipe, from which plates were cast and from which the coremaker struck up the loam core, afterwards striking the required thickness of loam on to make it the size required for the pattern. Two strickles were prepared, one for the core and one for striking on the thickness of loam for the metal.

Assuming that the core and pattern were ready, the lecturer proceeded to describe the method of using the template which had been sent from the engineers' shop or direct from the place of erection. The moulder bedded the template into the floor in the ordinary way, rammed up to the joint of the flanges, and there made a joint half-way (round the flanges only). Two stakes or files were then driven into the sand against the outside face of the flanges, these being allowed to project against the joint in order to ensure the top half of the flange following the same angle as the bottom half. The template was then drawn out of the sand and two half flanges were dropped into the impressions left by the template. The loam pattern was placed between the two flanges, the top halves of the flanges placed on the top of the pattern and rammed up in the ordinary way. When the pattern was liberated by the moulder the extra thickness allowed for metal was taken off, leaving the core, which was now dressed off ready to go back into the mould. The lecturer stated that he had found this method more sure and much easier than any other method tried.

Discussion.

Mr. Hurst thought the skeleton pattern was as economical as the loam pattern. Of course, the method of pipe-making was determined by the cost, just like anything else, and he should certainly say that the shell-pipe system was the cheapest of all. This was confirmed by the fact that almost all pipe shops adopted it. By this method the core was struck up with an edgeboard and this saved the accumulation of plates.

Mr. Midgley, replying to Mr. Hurst, said they had tried striking cores with the edge board to be used in conjunction with skeleton patterns, but they certainly preferred the loam patterns and the plates, as a more uniform thickness could be guaranteed by striking that thickness on the core and using it as a pattern. In working from skeleton patterns moulders had to exercise greater care or the pipe came out very uneven both in shape and thickness. Another point to take into consideration was that it took three times more timber to make a skeleton pattern than a board with the flanges on.

Mr. Hurst, continuing, said he gathered from the lecturer's remarks that in a shop like theirs every separate pipe must be considered on its merits and he agreed in that respect, as a shop that was not making pipes for the trade could not think of going to the expense of laying down a range of patterns for shell-pipe moulding.

Mr. Hanson (Halifax) said he had made pipes under all kinds of conditions, and he was certainly of the opinion that the method the lecturer had given by which they made their template pipes and pipes of irregular shape, was one of the best, considering the types of pipes which the lecturer's firm had to deal with. There was certainly less risk of anything going wrong in the actual moulding of the pipe, because the moulder started with the template, fitted his own flanges, placed his own pattern and used the same shape with the metal thickness of loam stripped for the core, and there was always a greater chance of success when one man handled a job practically from start to finish. If one considered cost only it meant specialisation and specialisation always produced cheaper; but when a sound and accurate casting was asked for in preference to the cost of the casting, he could find no fault with the methods the lecturer had given them.

Some New Chaplets.

In every branch of foundry practice it is fully realised that the minor details and requisites are of an importance equal to and as necessary as any other portion of the work, and require as much care and consideration in the production of successful castings as would be expended upon the more imposing portions. The truism "It's the little things that tell," although fully appreciated by most foundry men, is too often neglected, and the acceptance of the "near enough," or the inferior, often involves their reliance upon the element of chance, which in its outcome often leads to disaster. A very notable example of a minor foundry requisite which is often the source of much trouble is the common chaplet, and which, considering its important applications, has been very much neglected both as regards its design and reliability under casting conditions. While a chaplet's primary function is to hold and retain a core in position whilst the mould is filling, yet it should eventually become completely absorbed as a homogeneous portion of the casting. It, therefore, follows that to fulfil these conditions satisfactorily and with every sense of reliability the metal of which the chaplet is formed must be fusible at the required temperature, but before its complete absorption must ensure that the desired metal thickness in the casting is obtained. Owing to the possibilities of moisture collecting on chaplets, either in a liquid or crystalline form, measures have to be taken to prevent or counteract this danger, and these measures, in iron practice, usually take the form of tinning the material or filming it over with oil, in some cases

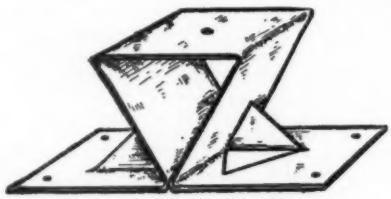


Fig. 1.—"Pinfix" Chaplet

both. With reference to the tinning of the material, its importance cannot be too fully recognised, as by its means rust—water in crystallisation—is obviated, and a badly-tinned chaplet is a danger which is the cause of many defective castings.

In their common designs chaplets range from the flat-headed nail of abnormal length—which in its utility requires "packing" to ensure rigidity—to abnormal and often grotesque forms, which in themselves show a lack of constructive principles, with a meagre idea of the conditions to be fulfilled. These

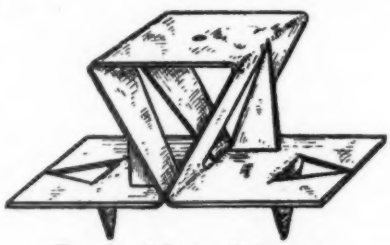


Fig. 2.—"Selfix" Chaplet

criticisms, however, can certainly not be applied to the designs we illustrate herewith, and which are the result of extended study of practical and technical requirements by a well-known foundry manager, and until recently used exclusively by him, and with remarkable success. In many respects their design is novel, but underlying their novelty is the clear application of sound constructive principles, and in Fig. 1, which is termed the "Pinfix," the ingenuity

Fig. 3.—"Clipit" Chaplet.

displayed for combining strength with every facility for obtaining complete fusion of the material, will be readily appreciated. This type, as its name implies, is for pin-fixing into position, and differs from the design in Fig. 2, the "Selfix," which makes its own provision for attaining this end in a reliable and entirely satisfactory manner. The "Clipit" form, it will be readily recognised, is for use with circular cores, the band portion providing the necessary grip

and the projecting part representing the metal between core and mould.

It will be seen that in each case the design involves the minimum of "foreign" metal to be introduced into the metal of the casting, combined with exceptional strength—features which will be appreciated by many who have had trouble with the old and crude forms. In neither case, in the event of all the metal of the chaplet not being thoroughly associated with its surrounding metal (an unlikely contingency), does the design leave a thick body of metal passing from inside to outside of the casting, such as occurs in some designs—a feature which makes all the difference between a good and a bad face at the spot, and is doubly important in the case of castings that have to stand pressure. The designs shown are now being placed on the market by the British Binderit Company, Southampton House, 317, High Holborn, W.C., who will supply further particulars to those interested.

Sand-Blasting Developments.

Discussing the question of "Safety in Sand-blasting," Mr. R. H. Parsons, in the "Electric Railway Journal," describes a somewhat novel installation, which dispenses with the usual method of protecting the operator by a hood over the head and by gloves. Fig. 1 illustrates a cabin 6 ft. square and 7 ft. high, inside a room about 12 ft. square and separated by floor-to-ceiling partitions from the other part of the building. Both the cabin and the outer room are built practically airtight. The cabin for the operator and the outer room for the sand and the work form in themselves a plant which

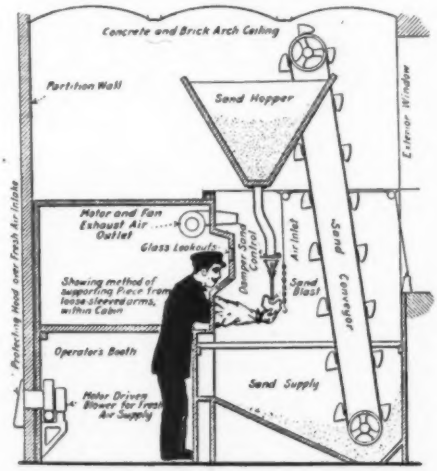


FIG. 1.—SAND-BLASTING ARRANGEMENT; WORKMAN IN CABIN.

neither interferes with or suffers interference from the rest of the shop. The cabin is built with a bay window at a height which permits the operator, when standing, to look at the work through a removable pane of glass. To reach and handle the work the operator puts his arms through the wall into long and roomy canvas sleeves. One end of each sleeve is permanently fastened to the wall, while the outer end is strapped to the wrists of the operator.

The sand-blast is directly in front of this bay window. As the hopper is just above the blast a clear, straight, non-clogging path is presented for the sand. A sliding damper in the pipe between the hopper and the blast nozzle is used to control the passage of the sand. This damper is within easy reach of the operator. A number of iron supports, located outside the cabin as shown, are provided for placing the work when not in the operator's hands. The air valve, shown in Fig. 2, is also easily reached by the sleeved arms of the operator. For additional

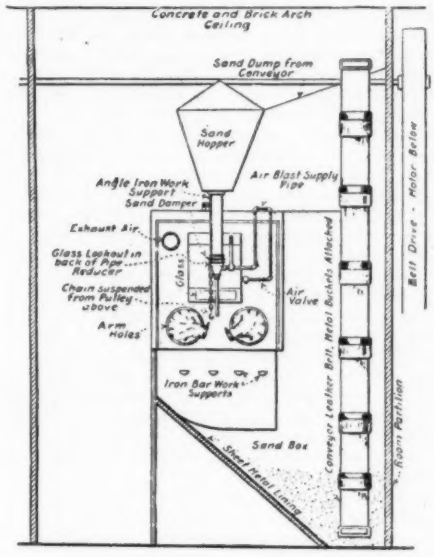


FIG. 2.—END VIEW FROM SAND-BLAST END.

convenience an air gauge is placed inside the cabin so that the operator can keep watch on the pressure. A hook attached to a rope which passes over two pulleys and fitted with a weight on the other end is suspended near the nozzle. This helps to support heavy parts.

The cabin is ventilated by two small blowers. The one shown in the left-hand corner of Fig. 1 draws fresh air from the outside of the main room directly into the cabin; the other at the top draws the foul air out of the cabin and also blows the sand-blast dust out of a window directly opposite. These fans keep both the cabin and the outer room fresh and clear.

A sheet-metal shute under the blasting nozzle allows the sand, after it has been used, to run into one corner of the sand room. Thence it is taken up on the belt conveyor illustrated in Figs. 1 and 2 to a shute which dumps the sand again into the hopper. The motor for this conveyor is located outside of the sand room. The blower motors and the switches for the conveyor motor are inside the cabin.

The sand-blasting apparatus itself is made up in the usual manner, consisting of a pipe T for 2½-in. pipe at the top and for 1-in. at the air intake and sand outlet. The top of the T is connected to the pipe from the sand hopper. The air is brought in through a pipe in the side, the pipe being reduced to ¼ in. and bent downward, with a very shall hole in the end. The damper previously mentioned is above the T, and a nipple which conveys the sand forced by the air to the work is screwed into the bottom. This nipple is about 10 in. long and is the only part which wears out; it is easily replaced.

Cupola Operation.

A meeting of the Birmingham Branch of the British Foundrymen's Association was held on Saturday, February 15, at Coventry, when Mr. R. Buchanan, F.R.S.A., gave an address on "The Origin and Development of the Foundry Cupola." Mr. C. Heggie (Branch President) was in the chair.

In the course of his remarks, the lecturer said that one of the earliest furnaces of which there was any record was the bloomery furnace, which was really the progenitor of the cupola as now known, and there were in England at the present time furnaces that differed from it in only a very slight degree. When cast iron came to be recognised as a merchantable product it was for a long time made in the same furnace as was used for the production of wrought iron. The user of the furnace when he wanted to make wrought-iron treated the ore in a furnace having a shallow bed of charcoal and with the blast blowing well on to the metal, so that it could not absorb carbon. If it did, the air would take the carbon out and so the metal would be left in the condition desired. The metal was also freely slagged, so that the air could get to it and keep the carbon down. When cast iron was required the tuyeres were raised, a larger bed of charcoal laid in and less blast used, so that the metal which was formed from the iron ore would take up sufficient carbon to become fluid and could be drawn away by tapping. When wrought iron was made the iron-maker took it out in a solid bloom. The old English blast furnace was of a more massive form. Instead of having plates to bind it together, its masonry was sufficiently massive to stand the heat and the weight of the charge without such aid. He had seen one of those furnaces at Blaenavon Works; it was not in use now, but it was still standing a few years ago. The thickness of the walls at the bottom was not less than 6 ft. 6 in. This model had not been copied in the cupola, which was practically a descendant of the bloomery furnace.

Coming to the cupola and the method of working it, the speaker referred to those types of furnace which were drawn in at the bottom. He had never made up his mind that this feature was an advantage, and had often debated whether the saving of coke effected was not more than counterbalanced by the cost of the extra labour required in fettling, to say nothing of the risk of hanging up just where the contraction of the contour started. With regard to having a receiver, opinion among foundrymen was very varied. To his mind the question whether or not a cupola should have a receiver depended largely upon the class of work to be done. A founder who was casting very large cylinders told him that he had worked a furnace without a receiver, but having tried a receiver he would not now do without it. One obvious advantage of a receiver was that a foundry with a particularly small output, but with occasionally a large casting and requiring very clean work, could gather the metal and so utilise the small cupola with advantage in making the large casting. There was thus avoided the necessity of having two cupolas, one of which would be most of the time standing idle. That consideration, to the lecturer's mind, covered the question, though it was also to be noted that with a receiver one could have the tuyeres nearer the bottom than if the metal had to be gathered in the cupola itself. It should, however, be borne in mind that with a receiver more work was required to get the complete apparatus ready for melting than was necessary when there was no receiver. In the Machiel cupola the receiver was really the bottom part of the cupola. There was a bridge extending over four-fifths of the bottom, and everything was kept up by that bridge. The metal when melted remained in the receiver and was gathered there. He preferred that cupola, as one could get exceedingly hot metal with a comparatively very small expenditure of coke; but the coke and the débris had to be drawn out at the end of the cast, whereas in drop-bottom types the bottom could be dropped and the cleaning out took very little time. The Whiting cupola had two rows of tuyeres, whereas the Thwaites had three. The tuyeres in the Whiting were made adjustable, but his experience of adjustable tuyeres was that if one worked for a time with one row only and then tried to use the second row, they could not be got open. He considered it was an advantage to have a second row, but only big enough to supply sufficient air to burn the gases which were formed below. This was better than letting the gases go up and burn by admitting air at the charging door. The latter was quite a common practice at some foundries, but when one saw a flame 9 or 10 ft. long coming out at the top of a cupola the inference was that the owner either had a lot of money to burn or did not know how to run a furnace. The second row of tuyeres should serve to burn the gases, but not to burn the coke, though it was probable that some of the coke also would be burned. As far as he knew, there was no melting in the cupola now done by gas, but some years ago he had experimented in the matter. The ash-bed was filled up with coke and instead of pure air a mixture of gas and air was played on to the bed. He melted 25 cwts. practically without any wastage of the coke; the cupola melted slowly, but hot, and he took out practically as much coke as he put in. That, of course, was not melting altogether by gas, because a bed of coke was used.

Dealing with the contour of linings, Mr. Buchanan said that there were many different opinions as to the best form. The tendency now was towards a perfectly vertical section, the cylindrical form. One often wished that one could get the linings of cupolas to last as long as did those of blast furnaces. He had seen a blast furnace which ran for eleven years without re-lining, but in the more modern blast furnace they were going back more to the type of the cupola. There was no doubt that in a wide blast furnace carbon was deposited on the walls and so preserved them, whereas in a blast furnace of the cupola type no carbon was deposited on the walls. He had seen only one water-cooled cupola, and that was in a steel works, and the wastage of the lining there amounted from 12 in. to 15 in. in a week, so that each week the lining, from the melting zone up to the charging door, had to be renewed. In the ordinary cupola frequent renewals were, of course, necessary, but it did not seem to him that it should be an absolute impossibility to design a cupola, the lining of which would last at least a week without requiring any renewal. With regard to blast pressure, Mr. F. J. Cook had shown that as the blast was increased the hardness increased. A few years ago it was pretty generally thought that the more air was blown in the better; but that idea was wrong. One foundryman known to the lecturer used a 22-oz. blast, his object being to get a very close-grained

metal, but in such a case it would be better to select a different metal to begin with and use an easier blast instead of using a soft iron and then hardening it by heavy blowing. On the other hand, another foundry used 15 cwt. of scrap to 5 cwt. of pig, and the castings came out quite soft, a 4 oz. or 5 oz. blast being used. That foundry was, in fact, buying coke instead of pig-iron.

Mr. Buchanan then went over very shortly various types of tuyeres, which were illustrated by diagrams. These included triangular, oval, flat and inverted T-shaped tuyeres. The lecturer pointed out the advantages and disadvantages of each type.

Discussion.

Mr. H. Pemberton (Derby) referred to the Baillot cupola, a French furnace, in which there was an arrangement to take gases from the top and burn them in the lower part. It always puzzled him to know why there should be gases at the top which ought to have been burnt at the bottom. This cupola was recommended as saving 20 per cent. of the fuel. As a matter of fact, this furnace, which had a receiver in front, did save fuel, but the hole between the cupola and the receiver got made up, and the general result of the trial convinced him that it was simply another case of trying to get something for nothing. The remarkably long life of a blast-furnace lining might be due to the fact that there was practically no oxidation taking place. In the blast furnace there was a reducing atmosphere, whereas the cupola there was an oxidising atmosphere. On one occasion he ran a cupola for 36 hours. After 24 hours' running he found that the contour of the lining was very little greater than after a 14- or 15-hour run. He examined the lining again at the end of the 36 hours, and decided to go on, and actually ran the cupola from Tuesday night until Saturday dinner time, without dropping the furnace or stopping at all. The furnace was in continuous blast all that time, and at the end showed a reduction to only 30 per cent. At the bottom the lining had begun to grow like a "bear" in a blast furnace.

Mr. Broughall, referring to the pipe shown in the diagram of the Thwaites cupola between the receiver and the cupola, said that it was doubtful whether this pipe served any very useful purpose, considering the amount of time and trouble necessary to keep it clear. With regard to the Machiel cupola, Mr. Buchanan seemed to hesitate a great deal before giving his verdict in its favour. A short time ago, he (the speaker) had occasion to make enquiries respecting the Machiel cupola, and could only offer a single objection to it, which was that it was not of the drop-bottom type.

Mr. P. V. Vernon (Alfred Herbert, Limited) asked what attempts had been made not only to utilise the heat, but also to collect the other products at the top of the cupola. He had some recollection of seeing an arrangement by which the dust which came out at the top was diverted into a vertical shaft and transferred to the bottom and removed, he thought, by a conveyor. He would also like to hear from Mr. Buchanan what were the objections to a drop bottom. A few years ago he visited eighteen or twenty foundries in the United States, and found that most of the up-to-date foundries had drop-bottom cupolas. With regard to the proverbial softness of American iron as compared with British, he made enquiries in the States, and could not find a single ironfounder who had even considered the question of how to make iron hard; there seemed to be in America not the slightest difficulty in getting hard iron. But a foundryman there when he spoke of good iron and good castings generally meant soft iron. He came to the conclusion that the Americans used soft iron because they preferred soft, and not because they could not get hard. In one or two foundries they were even importing Scotch pig for the purpose of getting their iron soft.

Mr. Wright remarked that in putting in a new cupola he had decided, after careful consideration, to have one with a solid bottom. He had no reason to regret his decision. As to tuyeres, he had found the form described as the expanding tuyere to be a very good one. He did not think it advisable to increase the area of the tuyere at the mouth, as that would tend to reduce the pressure of the blast at the point where it entered the furnace, but merely to spread out the tuyere to secure a better distribution of the blast. With the same aim in view he thought an upper row of tuyeres to be an advantage. There was a fixed amount of air required to convert the carbon of the coke to CO_2, which, of course, gave out the greatest heat, and the more general the distribution of the blast amongst the fuel the better for the furnace. His experience with regard to the shutters to the tuyeres had evidently been more happy than Mr. Buchanan's. He had doors to all the tuyeres, and had no difficulty in opening and closing them when it was desired to regulate the blast. The top row was always kept closed until the furnace was well under weigh and again when blowing down.

The Branch-President (Mr. Heggie) remarked that he had never yet met a foundryman who had worked with both forms and who was not in favour of the drop-bottom type.

Mr. Pearce (Coventry) remarked that something had been said in the lecture about the different conditions according to the observance of which either steel or iron was produced. He wondered whether there were any conditions under which something between the two, what he might call a mule iron, could be produced. He would also like to ask whether it had ever been thought advisable to use furnaces of different kinds according to the class of iron that was put in or had to be produced.

Mr. A. Harley (Coventry) expressed the opinion that unsatisfactory results with the drop bottom were probably caused by ramming in the bottom too hard. In such circumstances it was very difficult for the moisture to escape, and consequently the bottom was not thoroughly dry throughout by the time the metal came down. There were then emissions of steam which would have a tendency to cause cracks in the bottom and allow the molten metal to leak through. On the question of coke consumption, he did not think it was such an important factor as some made it out to be. After all, it was not worth while to spoil expensive castings for the sake of a little extra cost. He was not very much interested in romantic statistics relating the number of pounds of metal melted per pound of coke consumed, without detailed particulars of the class and quality of castings produced. If iron was produced at a temperature and condition suitable to the particular work in hand, resulting in uniformly good castings, there was not much to criticise in the working of the cupola. With regard to the shape of the tuyeres, he was inclined to prefer the rectangular—horizontally rectangular inside the cupola, and vertically rectangular next to the wind belt. He had not found any great advantage resulting from the use of a receiver. Where large quantities of metal had to be accumulated it might be an advantage in enabling metal of uniform quality to be got together quickly, but he thought the proper handling of the cupola would render a receiver unnecessary. To get a uniform quality of metal from a cupola that was

tapped in comparatively small quantities, more attention should be paid to the scrap, which was liable to vary in quality from day to day. There were two or three methods of getting over that difficulty. The best, when possible, was to let the stock of scrap accumulate and not use it up from day to day. The scrap could then be selected so as to ensure a regular supply of uniform composition. That, of course, meant systematic testing, for all iron used in casting should be tested daily if the work was such as had to meet a close specification.

Mr. Buchanan, replying, said that Mr. Pemberton was right about oxidation having a marked effect upon the lining of a cupola. Rust, of course, was oxide of iron, and if rusty scrap was used the lining soon wore out. But he did not know how Mr. Pemberton would account for the fact that a blast-furnace lining lasted so much longer than a cupola lining when it was remembered that a blast furnace made iron from iron ore, which was oxide of iron. Probably the explanation lay in the fact that the blast in a blast furnace of the wide type was not relatively so great as the blast in a cupola. If the blast went back to hit the walls again, there would be no carbon left on the walls because the blast would burn it. He often thought linings were made up too frequently and that it would be no disadvantage to run the cupola until there was only 2 in. of lining on the plates. It was a question whether it was good business when the cupola burned out to make it up again straight away; but at present the practice was to go on making up the lining day by day and week by week, putting on what the furnace took off. It was doubtful whether they had yet got the proper design for the cupola. In designing the modern blast furnace it was noticed that the wear was in certain directions and the design was made to obviate this. The ideal design for the cupola might perhaps be found by investigations on those lines. With regard to the ubiquitous and universal controversy about the drop bottom, he thought that one fact accounting for the almost universal use of the drop bottom in America was that in the greater part of industrial America the climatic conditions were different from those in Great Britain. As a rule, the summers were hotter and the winters—if not wetter—were colder. Therefore, in America, especially in the summer, it was very desirable to dump out as rapidly as possible. He had used drop-bottom cupolas with quite satisfactory results and only once had any metal dropping out—and then it did not for long. They took off the door at the front and stopped the blast while the moulder rammed the place. Then they replaced the door and went on and they never had any real trouble. His view was that if a cupola was small a drop bottom was of very little use, but that with a large one a drop bottom would be the best. But it did not follow that because the drop bottom was nearly universal in America it ought to be universal here. When he saw flames 9 or 10 ft. high coming out at the top, he always diagnosed bad practice. When the furnace was burning down the flame was usually red. When the flame was cream-coloured the furnace was doing very badly. Schemes for utilising the gases from cupolas were of no use. With regard to the softness of American castings, we here could make soft castings also, but when castings were dead-soft the only people who benefited were the machinists who built the machines. It was certain that the people who used machines made from dead-soft castings were not benefited.

On the motion of Mr. Broughall a hearty vote of thanks was given to Mr. Buchanan for his lecture.

Labour Disputes and Government Contracts.

The Board of Trade announces that the Government have received the following report from the Committee appointed to inquire and report on the question of production in engineering and shipbuilding establishments engaged in Government work :—

We have considered the question of disputes between employers and their workpeople which impair or are likely to impair the productive power of establishments engaged on Government work, and we are strongly of opinion that during the present crisis employers and workmen should under no circumstances allow their differences to result in stoppage of work. Whatever may be the rights of the parties at normal times, and whatever may be the methods considered necessary for the maintenance and enforcement of those rights, we think there can be no justification whatever for a resort to strikes or lock-outs under present conditions, when the resulting cessation of work would prevent the production of ships, guns, equipment, stores, or other commodities required by the Government for purposes of war.

We therefore submit for the consideration of his Majesty's Government the desirability of the immediate publication of the following recommendation to Government contractors and sub-contractors and to Trade Unions, and to request their adhesion to this recommendation for the avoidance of stoppages on work for Government purposes :—

"With a view to preventing loss of production caused by disputes between employers and workpeople, no stoppage of work by strike or lock-out should take place on work for Government purposes. In the event of differences arising which fail to be settled by the parties directly concerned, or by their representatives, or under any existing agreements, the matter shall be referred to an impartial tribunal nominated by his Majesty's Government for immediate investigation and report to the Government with a view to a settlement."

The Government have intimated their concurrence in the Committee's recommendation, and with a view to providing the necessary tribunal indicated therein they have extended the present reference to the Committee by empowering them to accept and deal with any cases arising under the above recommendation. The members of the Committee are :—

Sir George Askwith (Board of Trade);
Sir Francis Hopwood (Admiralty); and
Sir George Gibb (War Office).

Communications on the subject should be addressed to Mr. H. J. Wilson, Secretary to the Committee, at 5, Old Palace Yard, London, S.W.

Inventions.

Applications for Patents.

An asterisk indicates that a complete specification accompanies the application. When inventions are communicated the names of the communicators are in brackets.

571. Furnaces. C. Edmeston, sen.
782.*Processes and furnaces for generating heat. W. Thomas and A. E. Mainwaring.
1,010. Metal-melting furnaces. I. Hall.
1,173.*Tilting electric furnace for melting and refining metals. F. Bassanese.
1,213.*Manufacture of steel. F. T. Snyder.
1,230. Furnaces for hardening, annealing, and melting metals. I. Hall.
1,261. Automatic casting-machine. F. T. Davenport.
1,528.*Continuous casting. G. Mellen.
1,878. Superficially hardening steel. C. P. Sandberg.
1,930. Muffle furnaces for the recovery of volatile metals such as zinc. E. Gellbach.

Trade Talk.

MELDRUM BROS., LIMITED, of Timperley, Manchester, are paying a third and final dividend of 1s. 8¼d. in the £.

TATA, LIMITED, have removed from 6, Lombard Court, to Capel House, New Broad Street, London, E.C.

CONSIDERABLE damage has been done by a fire at the works of Calvert & Company, Limited, engineers and ironfounders, Folly Hall, Huddersfield.

THE MOLYBDENUM AND TUNGSTEN TRADERS, LIMITED, are being wound up voluntarily, with Mr. P. B. Smyth, 638, Salisbury House, E.C., as liquidator.

A MEETING of the shareholders of the Gillett Street Engineering Company (Preston), Limited, will be held on March 15 to consider the liquidator's accounts.

JOHN DAVIS & SON (DERBY), LIMITED, have started the manufacture of slide rules, of which so many have hitherto been imported from the Continent.

DURING January only one vessel was launched from the Tyne shipbuilding yards, as compared with four in the corresponding month of 1914.

MR. F. HALL, 5, Bowlalley Lane, Hull, has been appointed receiver of the North-East Coast Engineering Works (Hull), Limited.

COCHRANE BROS., LIMITED, have converted the old Seaview Foundry, near Bo'ness Docks, into a works for the manufacture of horse-shoes on a large scale.

MR. A. E. SKIDMORE, 55, Newhall Street, Birmingham, has been appointed receiver of Saunders, Davies & Company (Birmingham), Limited, brassfounders, Birmingham.

MR. G F. Ehrenzeller, of Pennsylvania Building, Philadelphia, has been appointed the American agent of the Carlton Iron Company, Limited, for ferro-manganese, spiegeleisen, etc.

VICKERS, LIMITED, and DICK, KERR & COMPANY, LIMITED, have been added to the official list of firms who are working on Government contracts, and whose employés, therefore, should not join the Army.

THE ALBERT WORKS, Radcliffe, near Manchester, of Messrs. John Wolstenholme & Son, engineers and iron and brass founders, were the scene of an explosion on January 30. Two men were injured, but the damage done to the works was inconsiderable.

THE partnership heretobefore subsisting between G. Clafton and A. J. McNaught, carrying on business as brass founders, at Mount Street, Fleetwood, under the style of A. J. McNaught & Company, has been dissolved.

THE shareholders of the Bristol Engineering Company, Limited, have passed a resolution winding-up the company voluntarily. Mr. F. E. Kewley, 12, The Straits, Fishponds, Bristol, has been appointed liquidator.

THE average price of Scotch pig-iron warrants during January was 62s., compared with 58s. 10½d. in December, 55s. 11½d. in November, 55s. 7½d. in October, and 57s. 3½d. in July. The prices for the corresponding month of 1914 was 56s. 7d.

WELLMAN, SEAVER & HEAD, LIMITED, have removed from 47, Victoria Street, Westminster, London, S.W., to larger and more convenient premises at India House, Kingsway, W.C. The company's telephone number will be "Holborn 1782."

MESSRS. H. O. THOMPSON and J. T. HUGHES-JONES carrying on business as engineers, at 20, Budge Row, Cannon Street, London, S.E., under the style of Thompson & Hughes-Jones, have dissolved partnership. Mr. H. O. Thompson will continue the business.

A BANKRUPTCY petition has been presented in the High Court of Justice against George Driver & Son, of Hythe Road, Willesden Junction, London, N.W., electrical and mechanical engineers, by Mr. D. S. Barclay, of "The Gables," Monkhams Drive, Woodford, Essex. The petition will be heard on March 5.

WE understand that the British Binderit Company, Limited, of 317, High Holborn, London, W.C., makers of the well-known foundry-sand and core-sand binder, are now manufacturing the product entirely in this country, and in view of the increasing demand, are acquiring a new factory on the Thames, which will shortly be in full operation.

SIR HERBERT MAXWELL, presiding at the annual meeting of Merry and Cuninghame, Limited, held at Glasgow, on February 24, reported that the company had purchased the Ardeer Ironworks and Ardeer and Auchenharvie Collieries. Sir William Beardmore, in reply to a shareholder who asked for information as to how the purchase price could be raised, indicated that the directors had power to issue debentures to the necessary amount.

AN order has been made in the Great Yarmouth County Court that the voluntary winding-up of G. F. Field & Son, Limited, engineers and iron and brassfounders, Beccles, Suffolk, be continued but subject to the supervision of the Court. Mr. E. H. Hawkins, 4, Charterhouse Square, London, E.C., has been appointed liquidator in addition to Mr. F. S. Cully, the liquidator in the voluntary winding-up.

AN exhibition of industrial gas-heated furnaces was opened by Professor J. O. Arnold, of the Sheffield University Applied Science Department, on February 15, and will remain open at 83, Nursery Street, Sheffield, until March 6. The exhibition consists of the productions of the Brayshaw Furnaces and Tools, Limited, of Manchester, and includes gas-heated furnaces for annealing, hardening, and tempering all classes of steel and small tools. Demonstrations are being given at intervals.

MR. DAVID CARNEGIE has established himself in business at 7, Victoria Street, London, S.W., as a consulting engineer and ordnance advisor. The partnership hitherto subsisting between Messrs. David Carnegie and Sydney Charles Gladwyn, as consulting engineers, at 33 to 35, Charterhouse Square, London, E.C., has been dissolved, and the business will now be carried on by Mr. Carnegie on his own behalf. This business has been transferred to the Victoria Street offices.

THE New South Wales Government propose spending a considerable sum on the further extension of the shipyard and foundry which they have established at Newcastle. The work to be undertaken by the new establishment includes the building of dredgers and hopper barges, at an aggregate cost of £104,000, and a floating dock for local use, which will involve an outlay of about £110,000. In the engineering section, railway bridge material, rock drills, and sewerage pipes are to be made when the necessary plant is provided.

A Bill has been introduced into the Canadian Parliament to prohibit the export of nickel while the war lasts, except, of course, to the United Kingdom. While giving no support to the belief that Canadian nickel is finding its way to Germany through the United States, where it has hitherto received its final treatment, the Ontario Provincial Government has decided to hold an inquiry into the whole question of the complete refinement of nickel in Canada. A Commission will be appointed with that object.

THE BIRMINGHAM METALLURGICAL SOCIETY are arranging for a special meeting on March 16 next, under the chairmanship of Professor Turner, Principal of the Metallurgical Department, Birmingham University, at which it is proposed to exhibit and invite discussion on all products of use to the metallurgical industries, for which we formerly depended to a great extent on foreign countries, and which are now being produced in this country. The meeting will be a representative one of Midland metallurgists and will provide an excellent opportunity for the exhibition of these new productions.

IN connection with the campaign undertaken by the Board of Trade on the advice of their Advisory Committee on Commercial Intelligence to assist British manufacturers and merchants to secure trade formerly in the hands of German or Austro-Hungarian firms, the board continue to receive a very large number of inquiries for the names of sellers or buyers of articles of which the sources of supply or markets have been interfered with by the war. Special arrangements have been made in the Commercial Intelligence Branch of the Board of Trade for dealing with these inquiries,

and List 8c of articles which inquirers desire to purchase is now ready, and may be obtained by United Kingdom manufacturers and traders.

THE BIRMINGHAM CHAMBER OF COMMERCE, having been in communication with the Board of Trade on the subject of the prevention of enemy's goods reaching this country through neutral territory, has received a reply, stating that, while the Board of Trade are not prepared to regard goods which left enemy territory before the outbreak of war as enemy goods, the cases in which permission to import such goods from neutral countries is granted are now comparatively few in number. Moreover, such permission is in general only granted in regard to particular consignments of goods which can be proved to have been brought from an enemy country before the outbreak of war, and to have remained in unbroken parcels in warehouse in a neutral territory since that date.

Deaths.

MR. S. C. PARMENTER, a director of the Crittall Manufacturing Company, Limited, of Braintree, died recently aged 83 years.

THE death has occurred of Mr. W. H Wheatley, consulting engineer and patent agent, Chancery Lane, London, W.C., at the age of 67 years.

MR. J. E. WALLIS, of Erdesley, Basingstoke, senior director of the engineering firm of Wallis & Steevens, Limited, died on February 23, aged 56.

THE death is announced of Mr. G. M. May, a director of Markham & Company, Limited, engineers, Broad Oaks Works, Chesterfield, at his residence, Orchard House, Brampton.

MR. I. HAYWARD, consulting engineer, of Middlesbrough, died recently at the age of fifty-nine years. The deceased gentleman specialised in the construction of wire mills.

THE death is announced of Mr. J. S. Clark, a director of the firm of George Clark & Sons, Limited, coppersmiths, brass finishers, etc., of Waterhouse Lane, Hull, at the age of 32 years.

MR. T. S. CLAPHAM, a director of Clapham Bros., Limited, engineers, of the Wellington, Nelson and Market Street Works, Keighley, died suddenly recently, at the age of 67 years. He was a son of one of the founders of the firm in the early part of last century.

MR. C. S. SCOTT, chairman of Scott's Shipbuilding and Engineering Company, Limited, of Greenock, has died at his residence, Halkshill, Largs. The deceased gentleman, who was 48 years of age, was one of the most prominent of the Clyde shipbuilders.

WE regret to announce the death of Mr. William Evans, J.P., which occurred on February 12, at his residence, Brynteg House, Merthyr, at the age of 72 years. The deceased gentleman was the general manager of the works and collieries in Wales of Guest, Keen & Nettlefolds, Limited.

MR. JOHN NICHOLSON, a well-known authority on the manufacture of steel, died at Belldale, Rawdon, near Leeds, on February 23. Born in 1836, Mr. Nicholson was the son of the late Mr. Benjamin Nicholson, founder in 1849 of the firm Benjamin Nicholson & Sons, of Shoreham Steel Works, Bramall Lane, Sheffield, and later carried on at the Nicholson Steel, File, and Tool Works, Attercliffe.

THE death took place suddenly on February 16 at Red Barns, Redcar, of Major Walter Johnson, J.P., of Arncliffe Hall, Northallerton, one of the most prominent of the North of England ironmasters. In 1871 he married the daughter of the late Sir Lowthian Bell, Bart., and a few years later he joined the firm of Bell Brothers, Limited. At the time of his death he had completed 40 years' association with it.

MR. J. DONALDSON died on January 28 at his residence, Almond Villa, Renfrew, in his 80th year He entered the employment of Messrs. William Simons & Company, shipbuilders, Renfrew, as a young man, and rose to be manager of the engineering department. Thirty years ago he left Messrs. Simons & Company, and afterwards conducted business in Glasgow as a consulting engineer and marine surveyor.

THE death is announced of Mr. John William Melling, chairman of the Worsley Mesnes Iron Works, Limited, at his residence, Swinley Road, Wigan, on January 27. Mr. Melling was 75 years of age. He served his apprenticeship as an engineer with the old Haigh Foundry Company, of Wigan, well known as a firm of great repute in the early days of locomotive building, heavy pumping engines and colliery winding engines.

THE death occurred on February 1, at his residence, Holme Bank, Rawtenstall, Lancs., of Mr. Spencer Culpan, head of the firm of S. Culpan & Son, Limited, Holme Bank Foundry, Rawtenstall. He was 79 years of age, and had served as foreman at Halifax and subsequently in a similar position for Messrs. Wood Bros., Sowerby Bridge. Then he became manager of Leebrook Foundry, Rawtenstall, and 30 years ago commenced business on his own account at Longholme, the engineering business developing so extensively that 20 years ago he removed to the present works at Holme Bank.

THE death of Mr. F. W. Lawson, of Oaklands, Adel, occurred at Bath on February 24. The son of the late Mr. John Lawson, of Beech Grove House, he entered in his youth the firm of Samuel Lawson & Sons, textile engineers, of the Hope Foundry, Mabgate, which was founded by his grandfather. It was carried on under its own distinctive title until the beginning of this century, when it was amalgamated with the business of two other large concerns engaged in the manufacture of textile machinery, the new company being known as Fairbairn, Lawson, Coombe, Barbour, Limited. Mr. F. Lawson became one of the directors of the amalgamation, and his brother, Sir Arthur Lawson, Bart., is the chairman.

MR. W. EDGAR ALLEN, a director of Edgar Allen & Company, Imperial Steel Works, Tinsley, Sheffield, and one of the greatest captains of industry of the steel metropolis, died on January 28 at his residence, Whirlow House, Sheffield, at the advanced age of 77 years. After receiving a sound commercial education in this country and in numerous Continental centres, he founded, in 1868, the business of Edgar Allen & Company, Imperial Steel Works, Sheffield. He commenced as a steel and file manufacturer and merchant, and early took advantage of his previous residence in various parts of the Continent. He supplied large quantities of railway material for Southern Europe, and executed extensive orders for foreign arsenals, dockyards, and similar undertakings. New branches were added to the works, and the ramifications increased so largely that in 1890 he turned the concern into a limited company, whereupon heavier manufactures were added to the undertaking, and the firm became noted for the excellence of their steel castings, while later they secured an extensive trade in tramway and railway material.

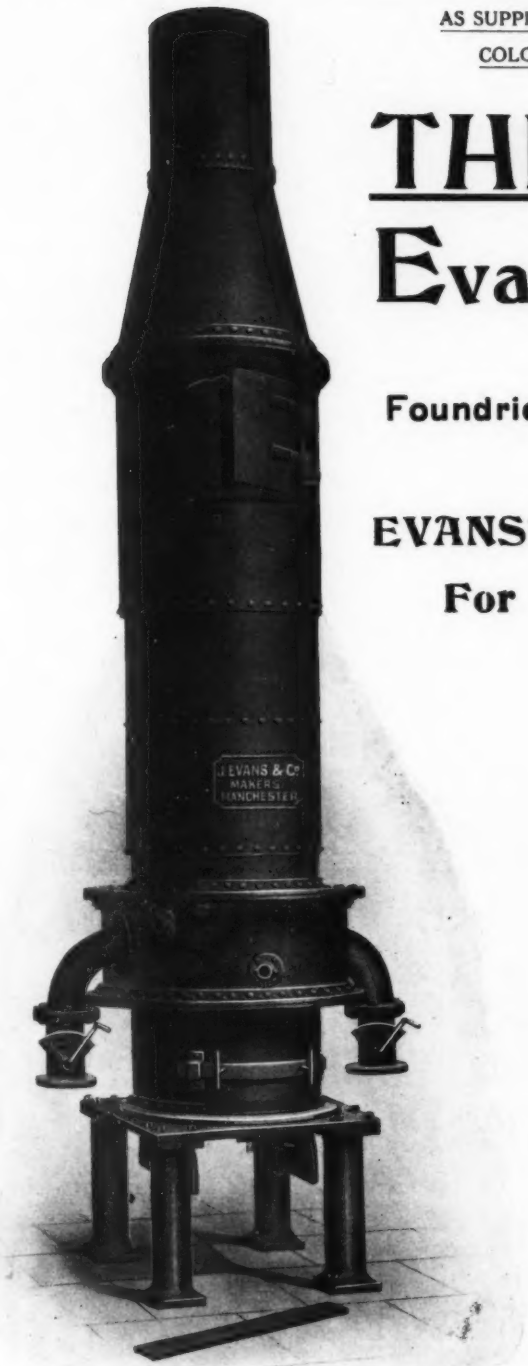
WE regret to announce the death of Mr. C. F. H. Bolckow, which occurred on February 12 at Torquay. The deceased gentleman was the oldest surviving representative of the family of the Bolckows, of Middlesbrough. It was Mr. Henry William Ferdinand Bolckow, uncle of the deceased gentleman, who, in association with the late Mr. John Vaughan, was the founder of the iron and steel industry, which is the chief bulwark in Middlesbrough's commercial prosperity. In the early days of Middlesbrough the deceased gentleman was actively associated with his uncle in the direction of the industry, which has grown to great proportions. In 1865, when the firm of Bolckow, Vaughan & Company was constituted a limited company, Mr. Carl Bolckow was a member of the original board of directors, and for many years after he continued his connection with the firm. For several years past he has been retired from business, and upon leaving Teeside he went to reside at Torquay, where he died, in his 80th year. The deceased gentleman was a deputy-lieutenant for the North Riding of Yorkshire and one of the oldest Justices of the Peace for Middlesbrough. He was also a Knight of Grace of St. John of Jerusalem.

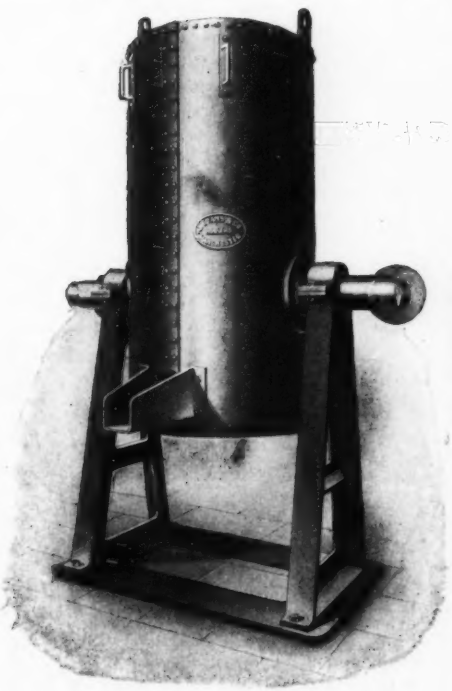
AS SUPPLIED TO THE ADMIRALTY, WAR OFFICE, COLONIES, AND FOREIGN GOVERNMENTS.

THE Cupola.
Evans's Rapid.

Foundries Completely Furnished.

EVANS'S NEW CUPOLETTE
For Emergency Work.





James Evans & Co.,
Britannia Works,
Blackfriars,
MANCHESTER.

Telegrams: "LADLES, MANCHESTER."
Telephone: 2297 CENTRAL, MANCHESTER.

New Companies.

Strong Light Alloys, Limited.—Capital £3,000 in £1 shares.

Active Engineering Company Limited.—Capital £5,000 in £1 shares.

Hunslet Steel Foundry Company, Limited.—Capital £500 in £1 shares.

Civil, Nautical and Mechanical Engineering Company, Limited.—Capital £100 in 2s. 6d. shares.

Engine Patents, Limited.—Capital £3,150 in 3,000 ordinary shares of £1 each and 3,000 founders' shares of 1s. each.

D. C. M. Manufacturing Company, Limited.—Capital £500 in £1 shares, to carry on the business of general engineers, etc.

John W. Bainbridge, Limited.—Capital £3,000 in £1 shares (1,000 6 per cent. preference), to carry on the business of ironfounders.

London Foundry Company, Limited.—Capital £25,000 in £1 shares, to adopt an agreement with the Electric Smelting Company, Limited.

Ridgacre Foundry Company, Limited.—Capital £2,000 in £1 shares. Registered office:—Ridgacre Foundry, Church Lane, West Bromwich.

Molybdenum, Limited.—Capital £1,050 in 1,000 ordinary shares of 1s., and 1,000 preferred of £1. Registered office: 124, Chancery Lane, W.C.

Howden Boiler and Armament Company, Limited.—Capital £150,000 in £1 shares, to carry on the business of boilermakers, engineers, ironfounders, etc.

Read, Son & Company, Limited.—Capital £500 in £1 shares, to carry on the business of engineers. Registered office: 27, Chancery Lane, London. W.C.

Harvey & Bishop, Limited.—Capital £100 in £1 shares, to carry on the business of ironfounders. Registered office:—16. Cannon Passage, Birmingham.

Elliston, Evans & Jackson, Limited.—Capital £1,000 in £1 shares, to carry on the business of engineers. Registered office: 56, Wilson Street, Finsbury, E.C.

C. S. Milne & Company, Limited.—Capital £3,000 in £1 shares, to carry on the business of engineers. Registered office:. 188, West Ferry Road, Millwall, London, E.

Personal.

Mr. R. G. Blake has been elected a director of William Jessop & Sons, Limited.

Mr. Lee Murray has resigned his seat on the board of Bruce Peebles & Company, Limited, of Edinburgh.

Mr. G. Turner, of Edgbaston, Birmingham, has been elected a director of Henry Bessemer & Company, Limited, in place of Mr. J. Barton, retired.

Mr. C. A. Ablett, general manager of the Siemens Company of Canada, has been given a commission as lieutenant in the Westmount Rifles of Canada.

Estate of the value of £282,094 gross, and £237,965 net, has been left by the late Mr. C. E. Chrimes, of Messrs. Guest & Chrimes, of the Rotherham Brass Works.

Mr. Sherard Cowper-Coles has been elected a vice-president of the Society of Engineers (Incorporated), thus filling the vacancy caused by the death of Mr. T. E. Bower last year.

Mr. J. H. Kemp has been elected a director of Fletcher, Russell & Company, Limited, Warrington, in place of the late Mr. T. Settle. Mr. Kemp is the company's Northern representative.

Mr. Ernest Bradley, of Messrs. Bradley & Turton, Limited, we understand, has joined the transport section and also the armoured-car section of His Majesty's forces and has been dispatched to the front.

The council of the North-East Coast Institution of Engineers and Shipbuilders have conferred the highest honour which the Institution can offer, the honorary membership of the Institution, upon Lord Fisher.

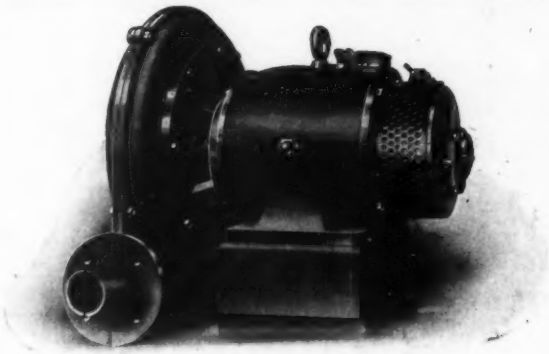
Mr. J. F. Taylor has resigned the presidency of the Lake Superior Corporation, Sault Ste. Marie, Ont., in order to devote his attention to the Algoma Steel Corporation, Limited, of which he is president and general manager. Mr. T. Gibson, of Toronto, will succeed Mr. Taylor.

Mr. Harry Astbury, Daimler House, Birmingham, representing the United Brassfounders and Engineers, Limited, Messrs. James Hendry, the Cambridge Scientific Instrument Company, Limited, and Messrs. A. and P. Steven, have appointed Mr. Collings H. Bishop as assistant engineer for the Birmingham district.

GANISTER, CUPOLA BLOCKS, FIRE BRICKS,
FIRE CLAY.
Silica Bricks, Tuyeres, Stoppers, Nozzles, &c.
STEEL MOULDERS' COMPOSITION, SILICA CEMENT.
J. GRAYSON LOWOOD & Co., Ltd.,
DEEPCAR, nr. SHEFFIELD.
Telegrams: "LOWOOD, DEEPCAR."

SANKEY Pressings & Stampings.

Any Size or Weight from Plate and Sheet Metal.
Rough or Machined. Foundry Ladles.
Write and let us know your requirements and we will quote you.
Joseph Sankey & Sons Ltd., Hadley, Salop.



10 H.P. Fan and Motor.

TRADE SIROCCO MARK

High Pressure Fans

Are made in a large number of sizes from 10 in. diameter upwards.

Bulletins 2000 F. and 2028 F.

Some Points worth noting.

Owing to few wearing parts, the Fans are not liable to break down. The mechanical efficiency is high and remains so. The pressure is steady and the volume even and free from pulsations.

Davidson & Co., Ltd.,

Sirocco Works,
BELFAST.

ELDERS FOUNDRY COKE

AS SUPPLIED TO THE BRITISH ADMIRALTY DOCKYARDS.

The following, selected from numerous letters, are eminent testimony as to the quality of our celebrated "A.A.A." Coppee Foundry Coke, carefully selected, and despatched in sheeted wagons.

From PECKETT & SONS, Bristol.

Bristol, October 25th, 1904.

We have been using your Selected Foundry Coke for some considerable time.
We have pleasure in stating that we are very pleased with it, as we find we get sounder and cleaner castings, more free from blowholes and other defects, than we formerly did.

From BOW, McLACHLAN & CO., LTD. (Paisley Foundry), Paisley, Glasgow.

Paisley, 12th March, 1909.

We have yours of 4th inst., and in reply have pleasure in stating that we have been using your Foundry Coke for several years for special purposes with highly satisfactory results.

Elders Collieries, Ltd., Cardiff.

Telegraph : ELDER, CARDIFF. Telephone : 4640 and 4641.

MONTHLY PRICE LIST.

The undermentioned prices, unless otherwise specified, are those obtaining on the first day of the current month.

Pig-iron.

	Feb. 26. s. d.
Cleveland.	
Cleveland No. 1	59 3
,, No. 3	57 3
,, No. 4 foundry	56 9
,, No. 4 forge	56 3
,, Mottled	55 9
,, White	55 9
East Coast hematite, mixed Nos. ..	90 0
Cleveland warrants	57 3½

Above prices are for early f.o.b. deliveries and as regards Cleveland iron are for G.M.B. brands. The warrant quotations are the sellers cash prices.

Scotland.

	s. d.
Standard Foundry (Glasgow Market settlement price)	56 9
Warrants, ditto	63 1½

Makers' prices:—	s. d.		s. d.
Gartsherrie No. 1..	78 6	No. 3..	73 6
Coltness No. 1..	95 0	No 3..	75 0
Summerlee No. 1..	78 6	No. 3..	73 6
Langloan No. 1..	77 6	No. 3..	72 6
Calder No. 1..	75 6	No. 3..	70 6
Clyde No. 1..	80 0	No. 3..	75 0
Carnbroe No. 1..	76 6	No. 3..	72 6
Monkland No. 1..	75 0	No. 3..	74 0
Shotts No. 1..	80 0	No. 3..	75 0
Govan No. 1..	70 0	No. 3..	69 0
(All deliverable alongside Glasgow.)			
GlengarnockNo. 1 .	79 0	No. 3..	74 0
(Deliverable alongside Ardrossan.)			
Dalmellington No. 1	74 0	No. 3..	72 0
Eglinton No. 1..	73 0	No. 3..	72 0
(Deliverable alongside Ayr.)			
Carron No. 1..	77 6	No. 3..	72 6
(F.a.s. Grangemouth.)			

Lancashire.

	s. d.	s. d.
Lancashire No 3 foundry f.o.t.	—	—
Lincolnshire No. 3 foundry ..	65 9	66 0
Derbyshire No. 3 foundry ..	64 0	64 6
Staffordshire No. 3 foundry ..	64 0	64 6
Cleveland No. 3 foundry ..	—	65 9
(All delivered equal Manchester.)		
Scotch No. 3 { Gartsherrie	—	—
Glengarnock	—	78 6
Eglinton	—	81 0
Summerlee	—	78 6
(Delivered Manchester Docks.)		

North-West of England.

	s. d.	s. d.
Bessemer mixed numbers net f.o.b.	—	90 0
Hematite warrant net cash ..	—	82 6
Lorn cold-blast charcoal iron ..	180 0	190 0

The Midlands.

	s. d.	s. d.
Staffs. { Common forge ..	55 0	56 0
Part Mine forge ..	60 0	61 0
Best All Mine ..	82 6	85 0
Cold Blast	—	130 0
Strong forge, about 1s. less than grey forge; Mottled and White, about 2s. less than forge; Foundry No. 3, 3s. to 5s. above forge; No. 1 and No. 2, from 1s. 6d. to 2s. above No. 3; No. 1, about 2s. above No. 2.		
Northampton foundry	—	—
North Staffs. foundry	—	—
Derby foundry	—	—
Nottinghamshire foundry ..	—	—
Leicestershire foundry	—	—
Shropshire Cold-Blast	—	132 6
(Delivered South Staffordshire Works, net cash monthly.)		

Lincolnshire.

	s. d.	s. d.
Forge	—	—
Grey forge..	—	—
Basic	—	—
No. 3 foundry	—	—
No. 4 foundry	—	—
F.o.t. Makers' works.		

South Wales.

	s. d.	s. d.
Welsh Hematite	90 0	92 6

Ferro-Alloys.

Net, Delivered Sheffield Steel works.

	£ s. d.
Ferro-chrome: 4/6% carbon. Basis 60%, scale 10s. per unit. Per ton	28 0 0
Ferro-chrome: 6/8% carbon. Basis 60%, scale 10s. per unit. Per ton	26 0 0
Ferro-chrome: 8/10% carbon. Basis 60%, scale 8s. 6d. per unit. Per ton	24 10 0
Ferro-chrome: Specially refined, guaranteed maximum 2% carbon, broken to small pieces for use in best quality crucible steels. Basis 60%, scale 22s. per unit. Per ton	65 0 0
Ferro-vanadium: 33/40% Va., per lb. of Va. contained in the alloy ..	0 9 0
Ferro-silicon: 45/50%. Basis 50%, 5s. scale per unit .. Per ton	15 0 0
Ferro-titanium: 15/18%, per pound, flat	0 0 6½
Ferro-molybdenum: 70/80% Mo. per pound of Mo. contained	0 18 0
Ferro-phosphorus: 20/25%. Per ton	16 10 0
*Ferro-manganese 80%	13 0 0
export	—

,, * F.o.b. Liverpool.

Iron Castings

Cleveland.

	£ s. d.	£ s. d.
Columns (plain)	7 7 6	to 7 12 6
Pipes, 1¼ to 2¼ in. ..	6 10 0	6 15 0
,, 3 to 4 in. ..	5 17 6	6 0 0
,, 5 to 8 in. ..	5 12 6	5 15 0
,, 10 to 16 in. ..	5 15 0	—
,, 18 to 24 in. ..	5 15 0	—
Chairs	4 7 6	4 10 0
Floor plates (open sand) (At work	3 10 0	3 12 6

Non-Ferrous Metals.

Copper.	£ s. d.	£ s. d.
Standard, Cash ..	64 7 6	64 12 6
Three months ..	64 15 0	65 0 0
Electrolytic	69 5 0	69 15 0
Tough	—	70 15 0
Best selected	—	70 15 0

Tin.		
Standard, Cash ..	177 10 0	178 0 0
,, Three months	157 5 0	157 15 0
English Ingots ..	—	175 0 0
Bars	—	176 0 0
Refined		—

Spelter.		
American	—	42 10 0
Specials	—	—
Hard	—	35 0 0
British	—	42 10 0

Lead.		
Soft foreign	—	20 2 6
English	—	20 15 0

Antimony.		
Regulus	—	75 0 0

Aluminium.		
Virgin Metal, 98/99%	..per ton	86 0 0

*Chromium (Metallic).		
98/99% purity per lb.	..	—

*Nickel.		
In cubes, 98/99% purity	Per ton	215 0 0

*Tungsten Metal Powder.		
96/98% purity .. per lb.	..	0 5 3

*Molybdenum Metal.		
96/98% purity.. per lb.	..	—

*Cobalt Metal.		
97% purity .. per lb.	..	0 7 6

Quicksilver.		
75 lb. bottle	..	12 7 6

* Net, Delivered Sheffield Works.

Scrap Iron and Steel.

Cleveland.

	s. d.	s. d.
Steel scrap, heavy melting ..	62 6	to 65 0
Iron scrap cast (cupola metal)	55 0	57 0

London (f.o.b.).

Heavy steel	56 6
Light ,, ...	40 0
Heavy cast	52 6

Non-Ferrous Scrap.

London merchants quote the following prices for scrap metal, delivered London, and subject to market fluctuations:—

	A. Joseph. £ s. d.
Hy. Electrolytic Copper Scrap ..	68 0 0
Hy. Selected Scrap Brass	50 0 0
Hy. Tinned Copper Wire ..	64 0 0
Best Selected Gunmetal Scrap	62 0 0
Re-melted Ingot Lead 10s. under English Lead price on date of order.	
Plumbers Solder	72 0 0
Tinmans ditto	92 0 0
Blowpipe ditto	102 0 0

Stocks.

Pig-iron in Public Store.

	Feb. 25. Tons.	Inc, + or Dec, — since Feb. 26, 1914. Tons.
Connal's at Glasgow Scotch	1,000	No change.
Ditto other makes ..	—	— 12
Connal's at Middlesbrough	123,229	— 12,079
Connal's at Middlesbrough, hematite ..	—	No change.
West Coast hematite..	4,412	— 4,012

Metals.

Copper, Europe and afloat	—	—
Tin, London, Holland, U.S.A. and afloat .	—	—

Coke.

Middlesbrough.

	s. d.	s. d.
Gas Coke	13 6	—
Foundry Coke ..	19 6	to 21 0
Furnace coke	—	17 9

Newcastle-on-Tyne.

	F.o.b	Dunston, s. d.
FOUNDRY COKE—		
Original Garesfield		19 6
Mickley		19 6
Stella Garesfield		19 6
Priestman's Garesfield		20 0
Consett Garesfield		19 6
Newcastle gas coke		13 0

Cardiff.

	s. d.	s. d
Special foundry coke ..	33 0	to 36 0
Foundry coke	28 0	to 32 0
Furnace coke	22 0	to 24 0

Leeds.

Furnace coke (washed) ..	14 0	to 15 0

Birmingham.

Foundry coke	—	—
Furnace ,, ...	—	—
Gas ,, ...	—	—

Glasgow.

Foundry coke	—	—
Furnace ,, ...	—	—
Gas ,, ...	—	—

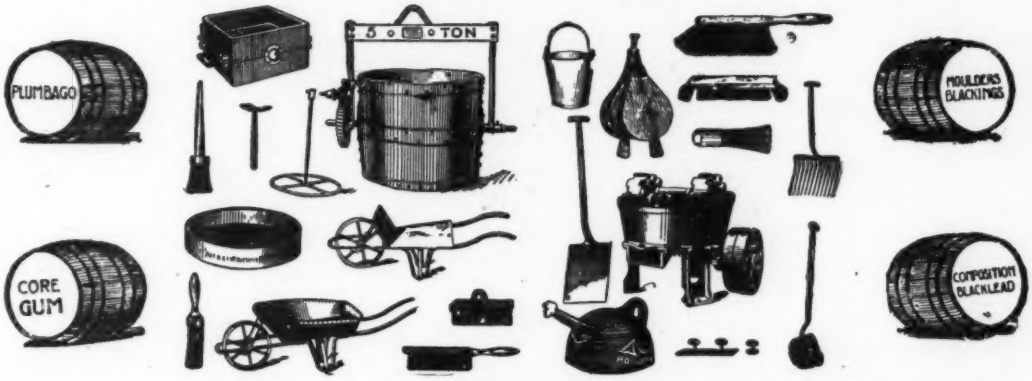
London.

Foundry coke	—	—
Gas coke (Beckton), into barge	—	—
,, into wagon at Works	—	—
Gas coke, Provincial (London sidings)	—	—

Established 1863.

JAS. DURRANS & SONS,

Phœnix Works, Penistone, Near Sheffield.



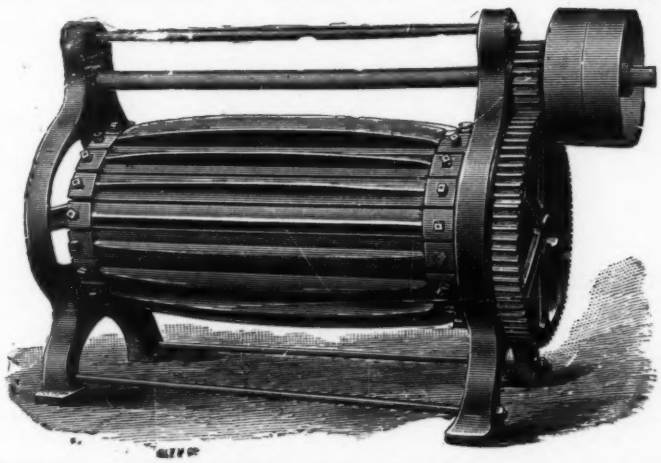
Manufacturers of all

FOUNDRY EQUIPMENTS

COMPOSITION BLACK LEAD, PLUMBAGO, CORE GUM, WHITE DUST & COAL DUST

Ladles, Cupolas, Fire Bricks, Gannister, Stone Flux, Loam and Sand Mills, Casting Cleaners, Studs, Chaplets, Pipe Nails, Sprigs, Brushes, Wire Brushes, Core Ropes, Bellows, Buckets, Spades, Forks, Riddles, Sieves, Barrows, Etc.

Improved Foundry Rattler or Fettling Drum.

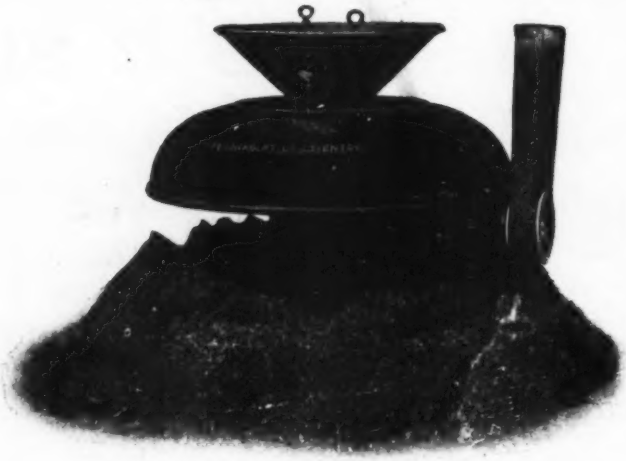


These Machines are invaluable for a Foundry, doing a larger amount of work of a superior quality, in a much shorter time than can be done by hand, without skilled labour.

The following testimonial explains itself :—

"Dear Sirs,—We have been using your best Blacking for a large number of years, and always use it on our large Ingot Moulds, which, as you know, we have made up to 85 tons in weight.

Yours faithfully, THE BRIGHTSIDE FOUNDRY & ENGINEERING CO., LD.



Patent Sand Mixer

Uses up more old sand than has hitherto been considered possible.

Our Patent Sand Mixer has the following desirable advantages.

The sand is thoroughly aerated, rendered light and loose in texture and of even temper.

Previous milling of the sand is unnecessary.

Seven hundredweights of sand dealt with per minute.

All bearings are ball bearings.

All gears are casehardened steel.

All gears and bearings run in an oil-bath rendering them practically everlasting.

Cages easily examined and cleaned.

Cages do not clog as there are no curved passages.

Machines can be seen in operation in our foundries, Edgwick, Coventry.

ALFRED HERBERT, Limited,

Coventry.

SITUATIONS VACANT AND WANTED.

FOUNDRY FOREMAN wanted for Barcelona, Spain, with thorough knowledge of mixing, moulding, and pouring chilled Cast Iron Rolls for Flour Milling Cylinder Machines. Must be capable of installing and working a small Foundry.—Write, giving age, experience, and remuneration required, to INDUSTRIAS MECANICAS, Apartado, No. 310, Barcelona, Spain.

DRAUGHTSMAN required, with practical knowledge of Industrial Furnace construction preferred.—Apply, with full particulars of experience, reference, and salary required, to Box 550, Offices of THE FOUNDRY TRADE JOURNAL, 165, Strand, London, W.C.

WANTED.—A Firm situated in the South of England, making some of their own Castings, are desirous of making their own Steel Castings, about seven or eight tons per week. An exceptional opportunity occurs for a man well up in the making of Steel Castings to have the control.—Address Box 552, Offices of THE FOUNDRY TRADE JOURNAL, 165, Strand, London, W.C.

FOR SALE AND WANTED.

HALL'S INVINCIBLE SAND MIXERS will utilize your Old Sands and prepare New Sands at the lowest cost per ton. Grinds, Screens, Mixes, and Toughens at one operation. To be seen at work.—Apply C. E. V. HALL, Paradise Chambers, Sheffield.

TO BRASS FOUNDERS AND OTHERS.—For SALE, almost new HAND MOULDING MACHINE, SAND MILL, ROTARY SIEVE, First Class GAS ENGINE, LATHES, and other Machines.—Apply Box 490, Offices of THE FOUNDRY TRADE JOURNAL, 165, Strand, London, W.C.

FOR SALE AND WANTED—(*Continued.*)

A No. 30 BAKER BLOWER or EXHAUSTER, practically new, with machine-cut steel wheels, outside bearings and pulleys. Price £80, free on rails.—Apply JOHN VARLEY & CO., LTD., Waterloo Foundry, St. Helens.

TWO LLOYD'S BLOWERS, each 10 in. inlet and outlet, with belt pulley on bracket; one small BLOWER, 2½ in. suction and discharge, with fast and loose pulleys; all in good order and cheap.—C. F. DAVIS, 18, Billiter Buildings, London, E.C.

COMBINED MORTAR MILL, ENGINE and BOILER 7 ft. pan; ditto, with 6 ft. pan.

JOSEPH PUGSLEY, Cattybrook Ironworks, Lawrence, Hill, Bristol.

NAISH & CROFT,

Consulting Metallurgists and Analytical Chemists.

— SPECIALISTS IN FOUNDRY WORK. —

Laboratory for all kinds of Metallurgical Investigations.

ANALYSES. MICROGRAPHS. MECHANICAL TESTS.

When you have trouble write us. Fees on application.
Special Terms for Contract Work.

Address : **150, ALMA STREET, BIRMINGHAM.**

London Office : 9 & 10, Fenchurch Street.

FRODAIR

SPECIAL PIG IRON

for

CYLINDERS, CHILLED CASTINGS, MACHINE CASTINGS, and any :: :: FOUNDRY PURPOSE. :: ::

ASK FOR OUR SUGGESTIONS FOR ECONOMICAL IRON MIXTURES.

THE FRODAIR IRON & STEEL CO., LTD.,

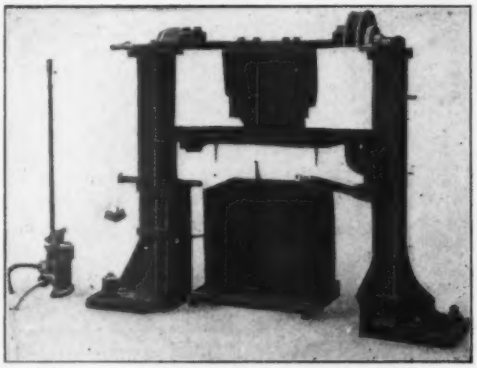
Fenchurch House, LONDON, E.C.

THE "CHIPCHASE" PATENT

MOULDING MACHINE.

(HYDRAULIC or PNEUMATIC)

SIMPLE - STRONG - DURABLE



This illustration shows the 3rd position in the making of axle boxes.

THE "CHIPCHASE" PATENT JARRING MACHINE.

THE "CHIPCHASE" PATENT CORE MAKING MACHINE.

Sole Makers—

DAVID BRIDGE & Co., Ltd.,

CASTLETON FOUNDRY, CASTLETON, MANCHESTER.

38¼"
McNEIL'S
PATENT UNBREAKABLE
STEEL LADLES
These Ladles are manufactured by a patented process, each from a single steel plate without weld or rivet. They are extremely light, being at the same time the strongest and most durable in the market. Ladles to contain 56 lb. of metal only weigh about 7 lb. each. They are made of all capacities from 30 lb. to 60 cwt., with or without lips; also mounted or unmounted. They are also suitable for chemical and metallurgical processes. List of sections and prices on application to
CHAS. McNEIL.
KINNING PARK IRONWORKS,
GLASGOW.
36"
32½"

Can also be made in Aluminium.

WHITTAKER'S IMPROVED MOULDING MACHINE

By which Wheels or Pulleys of any description or size from 3 inches to upwards of 20 ft. diameter can be made.

The most complete and efficient machine hitherto introduced to Engineers.

All Machines warranted to Mould with the greatest accuracy and precision.

GEARING WHEELS

Spur or Bevel, Straight Teeth and Double Helical Teeth Supplied to Consumers.

ROPE & BELT PULLEYS.

WM. WHITTAKER & SONS, LTD.,

SUN IRON WORKS, ***OLDHAM.***

JOHN HALL & CO.

OF STOURBRIDGE, LIMITED,

STOURBRIDGE, ENGLAND.

Manufacturers of

FIRE BRICKS, BLAST FURNACE BRICKS AND CUPOLA BRICKS.

CUPOLA BRICKS

FOR LINING ORDINARY AND PATENT

CUPOLA FURNACES.

JOHN R. FYFE & Co.,

SHIPLEY, Yorks.

FERRO-VANADIUM. * * * FERRO-TITANIUM.

SILICO-MANGANESE 23/30 % Silicon, 65/70 % Manganese & 1 %, 2 %, 3 %, Carbon Maximum.

FERRO-SILICON Containing 25 %, 50 %, 75 % Silicon.

FERRO-CHROME 65/70 % Cr. & 1 % up to 8/10 % Carbon Maximum.

ALUMINIUM 98/99 % Purity. *In Notched Bars and Half Round Sticks and Granular.*

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EVERITT & CO., 40, CHAPEL ST., LIVERPOOL.

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SOLE MAKERS OF

"PEHRSON'S PATENT STEEL MOULDERS' GREENSAND."

FOR LIGHT CASTINGS. SAVES DRYING IN STOVES.

Compositions for

BESSEMER, SIEMENS, AND CRUCIBLE STEEL CASTINGS, CORES, ETC.

SILICA PAINT.

GROUND GANISTER FOR ALL KINDS OF FURNACES.

SILICA CEMENT.

GANISTER SUPPLIED IN ROCK, CALCINED OR BROKEN.

Makers of

GANISTER BRICKS and FIREOLAY GOODS of every description.

STEEL RUNNERS, STOPPERS, NOZZLES, ETC.

CRUCIBLE CLAY OF THE FINEST QUALITY.

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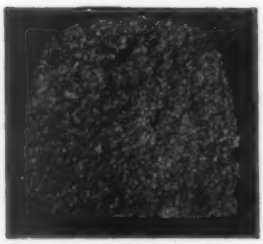
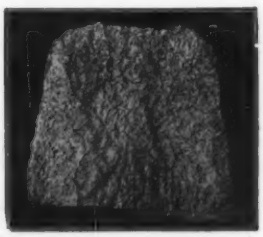
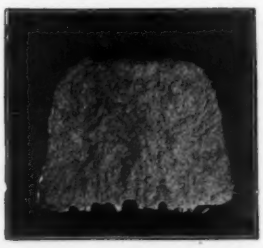

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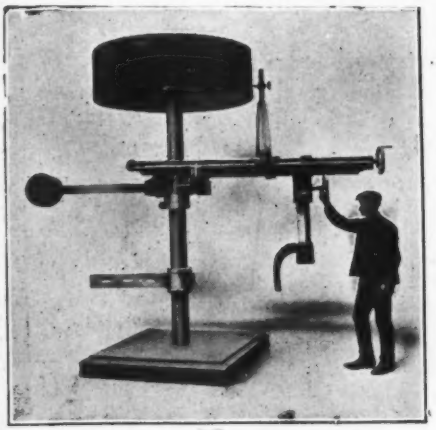

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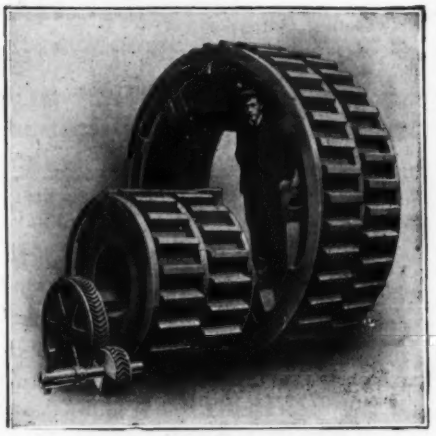

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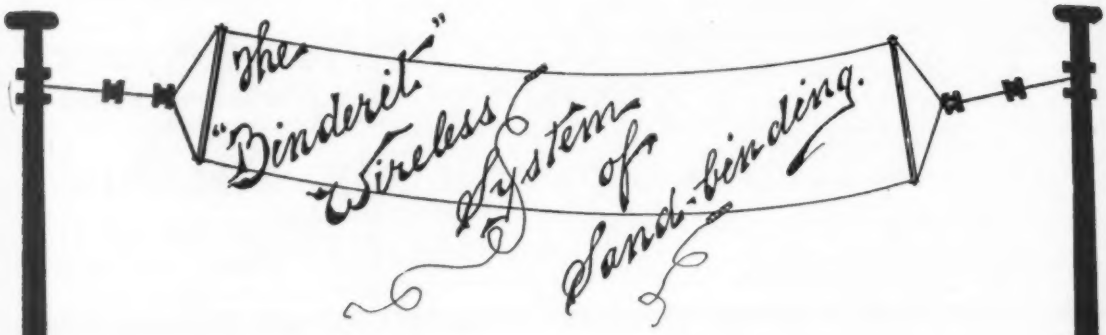

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THE BRITISH BINDERIT CO. specialise in those requisites which are absolutely necessary for successful castings production.

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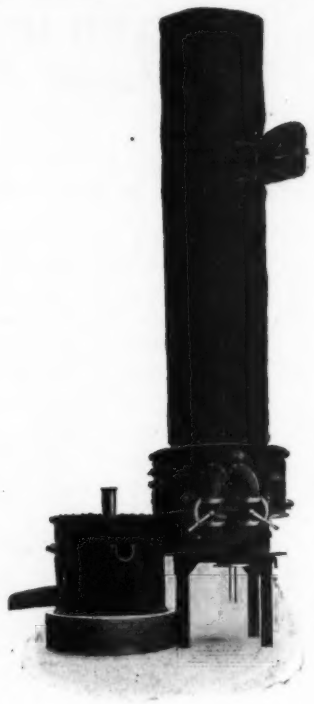

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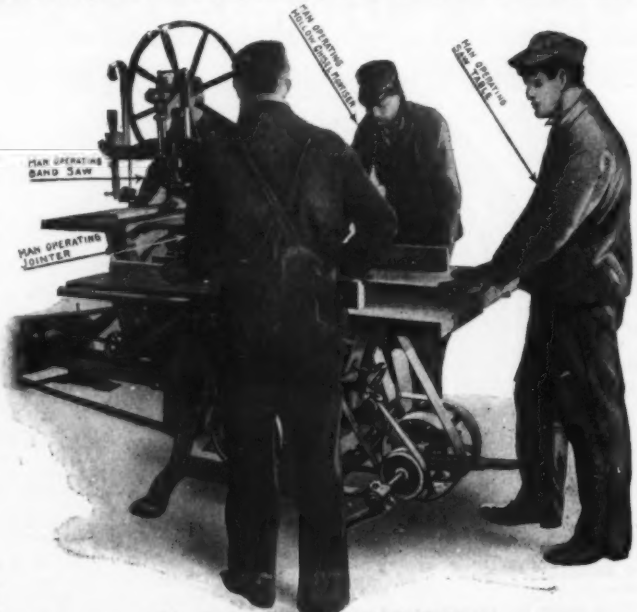

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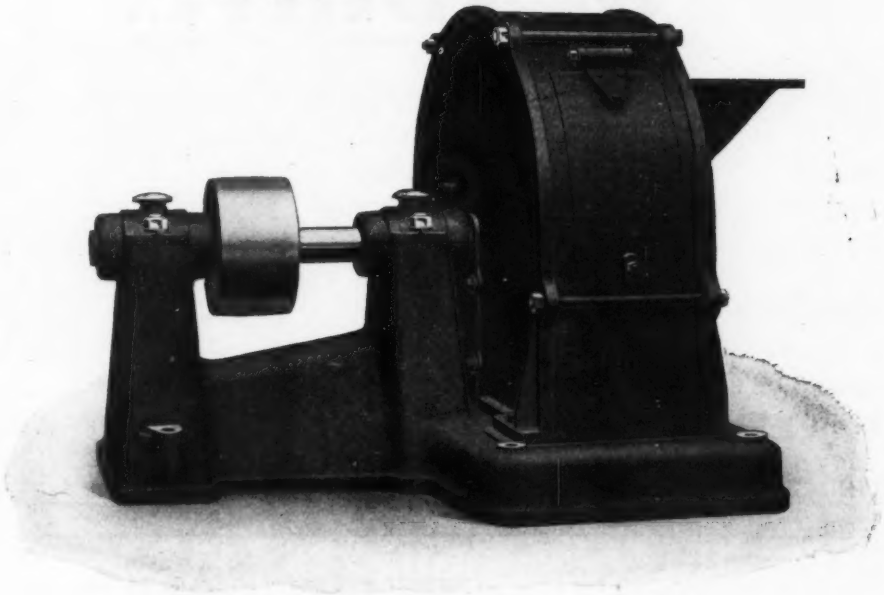

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